Marine Engineering

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MAY 5 1921
U. S. PATENT OFFICE

Fig. 1.—S.S. *Oropesa*, from an Original Painting by Arthur J. W. Burgess, R. I.

Passenger and Cargo Steamer Oropesa

New Twin Screw Vessel Added to the Fleet of The Pacific Steam Navigation Company

THE large passenger and freight vessel *Oropesa,* recently placed in the New York, Cherbourg, Southampton service, by the Pacific Steam Navigation Company, is a beautiful example of modern practice for vessels of this type.

Constructed at the shipbuilding yard of Messrs. Cammell Laird and Company, Ltd., at Birkenhead, England, the *Oropesa* was launched December 9th of last year.

Principal Dimensions

Designed for a displacement of 24,000 tons and a sea speed of 14½ knots, the vessel is of the following dimensions:

Length	552 feet
Breadth molded	66 feet
Depth molded to shelter deck	45 feet
Gross tonnage	14,500 tons

The vessel is built of steel under special survey for Lloyds 100 A-1 class, with Board of Trade Certificate for the carrying of passengers and fulfills the requirements of the Spanish Emigration Law and the International Convention requirements for passenger vessels.

Passenger Accommodations

Of particular interest is the manner in which the accommodations for passengers have been arranged and the elaborate decorations and furnishings provided, every comfort and luxury being cared for.

Accommodation for 143 first class, 131 second class and 366 third class passengers is provided, making a total of 640.

First Class

Situated at the fore end of the bridge deck is the first class lounge and music room, a spacious room with raised ceiling and finely panelled sides.

The furniture is of polished mahogany, arranged to give a cosy effect, and the floor is laid with suitable Rublino tiles.

Fig. 2.—First Class Dining Saloon

Fig. 3.—Second Class Double or Four-Berth Cabin

Fig. 4.—First Class Social Room

Fig. 5.—Second Class Social Room

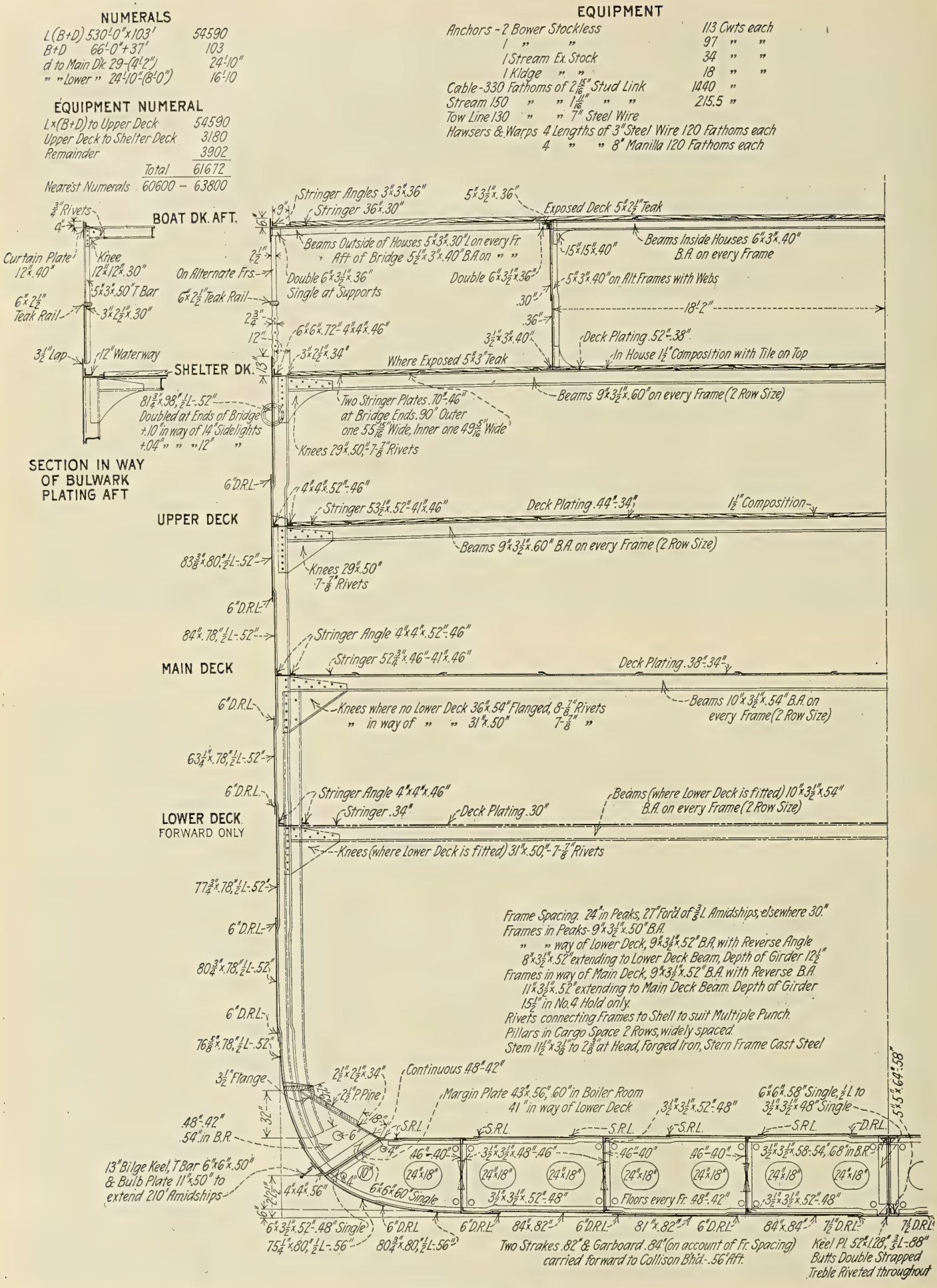

NUMERALS
L(B+D) 530'-0"x103' 54590
B+D 66'-0"+37' 103
d to Main Dk. 29-(4'-2") 24'-10"
" "Lower" 24'-10"-(8'-0") 16'-10
EQUIPMENT NUMERAL
L x(B+D) to Upper Deck 54590
Upper Deck to Shelter Deck 3180
Remainder 3902
Total 61672
Nearest Numerals 60600 – 63800
EQUIPMENT
Anchors - 2 Bower Stockless 113 Cwts each
1 " " 97 " "
1 Stream Ex. Stock 34 " "
1 Kidge " " 18 " "
Cable - 330 Fathoms of 2 15/16" Stud Link 1440 "
Stream 150 " " 1 15/16" " " 215.5 "
Tow Line 130 " " 7" Steel Wire
Hawsers & Warps 4 Lengths of 3" Steel Wire 120 Fathoms each
4 " " 8" Manilla 120 Fathoms each
BOAT DK. AFT.
SHELTER DK.
SECTION IN WAY OF BULWARK PLATING AFT
UPPER DECK
MAIN DECK
LOWER DECK FORWARD ONLY
Stringer Angles 3"x3"x.36"
Stringer 36"x.30"
5"x3 1/2"x.36"
Exposed Deck 5"x2 1/2" Teak
Beams Outside of Houses 5"x3"x.30" L on every Fr.
" Aft of Bridge 5 1/2"x3"x.40" B.A. on " "
15"x15"x.40"
Beams Inside Houses 6"x3"x.40" B.A. on every Frame
Double 6"x3 1/2"x.36"
Single at Supports
Double 6"x3 1/2"x.36"
5"x3"x.40" on Alt. Frames with Webs
Curtain Plate 12"x.40"
Knee 12"x12"x.30"
5"x3"x.50" T Bar
On Alternate Frs.
6"x2 1/2" Teak Rail
3"x2 1/2"x.30"
.30"
.36"
18'-2"
Deck Plating .52"-.38"
In House 1 1/2" Composition with Tile on Top
3 1/2" Lap
12" Waterway
3"x2 1/2"x.34"
Where Exposed 5"x3" Teak
3 1/2"x3"x.40"
Beams 9"x3 1/2"x.60" on every Frame (2 Row Size)
Two Stringer Plates .70"-.46" at Bridge Ends .90" Outer one 55 15/16" Wide, Inner one 49 5/16" Wide
Knees 29"x.50" 7-7/8" Rivets
Deck Plating .44"-.34"
1 1/2" Composition
Stringer 53 1/2"x.52"-41"x.46"
Beams 9"x3 1/2"x.60" B.A. on every Frame (2 Row Size)
Knees 29"x.50" 7-7/8" Rivets
Stringer Angle 4"x4"x.52"-.46"
Stringer 52 3/4"x.46"-41"x.46"
Deck Plating .38"-.34"
Beams 10"x3 1/2"x.54" B.A. on every Frame (2 Row Size)
Knees where no Lower Deck 36"x.54" Flanged, 8-7/8" Rivets
" in way of " " 31"x.50" 7-7/8" "
Stringer Angle 4"x4"x.46"
Stringer .34"
Deck Plating .30"
Beams (where Lower Deck is fitted) 10"x3 1/2"x.54" B.A. on every Frame (2 Row Size)
Knees (where Lower Deck is fitted) 31"x.50" - 7-7/8" Rivets
Frame Spacing. 24" in Peaks, 27" For'd of 3/8 L. Amidships, elsewhere 30."
Frames in Peaks - 9"x3 1/2"x.50" B.A.
" " way of Lower Deck, 9"x3 1/2"x.52" B.A. with Reverse Angle 8"x3 1/2"x.52" extending to Lower Deck Beam, Depth of Girder 12 1/2"
Frames in way of Main Deck, 9"x3 1/2"x.52" B.A. with Reverse B.A. 11"x3 1/2"x.52" extending to Main Deck Beam. Depth of Girder 15 1/2" in No. 4 Hold only.
Rivets connecting Frames to Shell to suit Multiple Punch.
Pillars in Cargo Space 2 Rows, widely spaced.
Stem 11 1/2"x3 1/8" to 2 3/8" at Head, Forged Iron, Stern Frame Cast Steel
Continuous 48"-42"
Margin Plate 43"x.56", .60" in Boiler Room
41" in way of Lower Deck
3 1/2"x3 1/2"x.52"-48"
6"x6"x.58" Single, 1/2 L to 3 1/2"x3 1/2"x48" Single
5"x5"x.64"-.58"
S.R.L.
D.R.L.
Floors every Fr. 48"-42"
Keel Pl. 52"x1.28", 3/4 L-.88"
Butts Double Strapped Treble Riveted throughout
Two Strakes .82" & Garboard .84" (on account of Fr. Spacing) carried forward to Collison Bhd. - .56" Aft.
6"D.R.L.
4"x4"x.56"
6"x6"x.60" Single
13" Bilge Keel, T Bar 6"x6"x.50" & Bulb Plate 11"x.50" to extend 210' Amidships
48"-42"
54" in B.R.
2 1/2"x2 1/2"x.34"
2 1/2" P. Pipe
3 1/2" Flange
32"
18"
6
4"
46"-40"
24"x18"
10"
6"x3 1/2"x.52"-48" Single
75 1/4"x.80", 1/2 L-.56"
80 3/4"x.80", 1/2 L-.56"
84"x.82"
81"x.82"
84"x.84"
7 1/2" D.R.L.

Fig. 6.—Section in Way of Hold

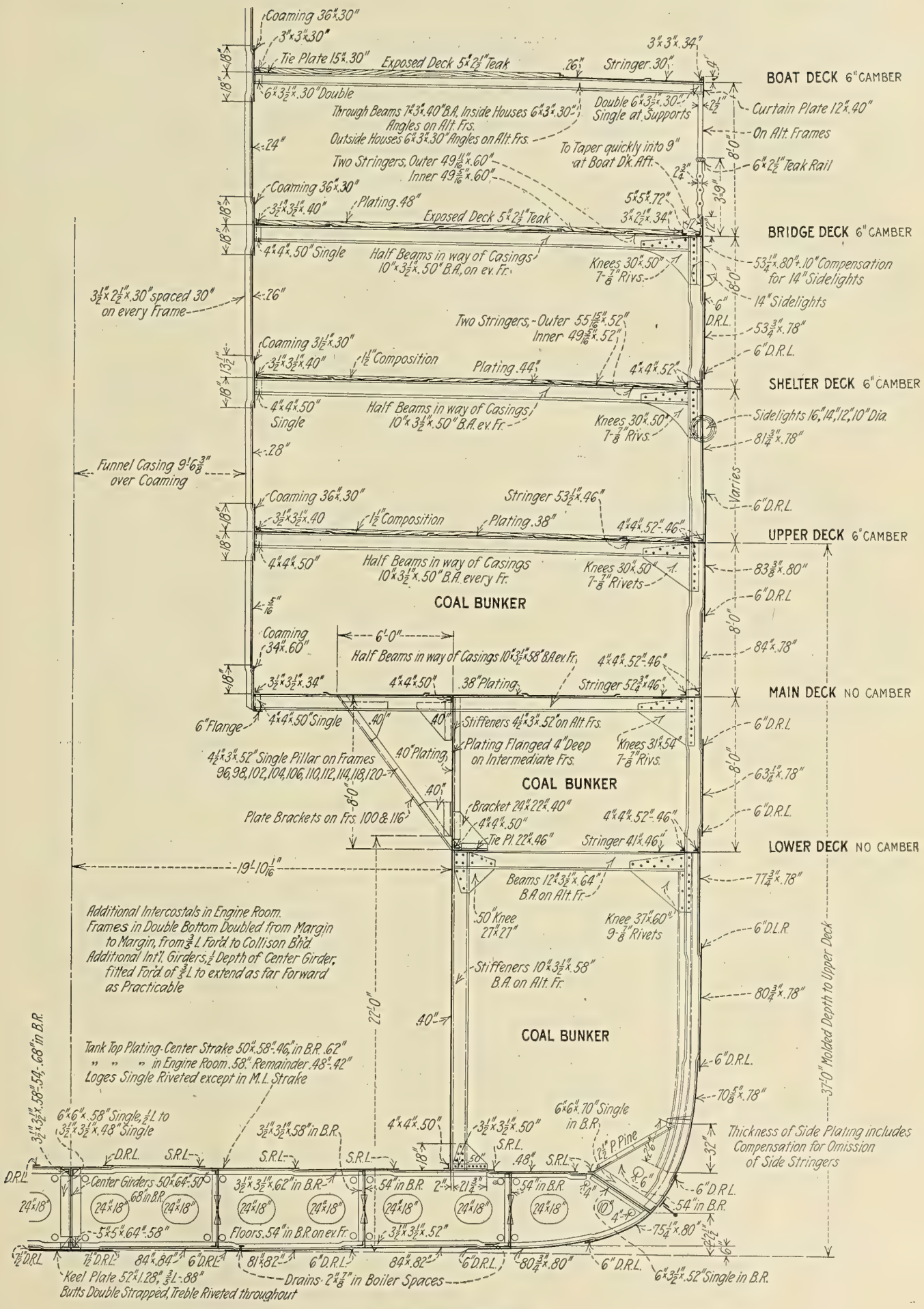

BOAT DECK 6" CAMBER
BRIDGE DECK 6" CAMBER
SHELTER DECK 6" CAMBER
UPPER DECK 6" CAMBER
MAIN DECK NO CAMBER
LOWER DECK NO CAMBER
COAL BUNKER
COAL BUNKER
COAL BUNKER
Coaming 36"x.30"
Exposed Deck 5"x2½" Teak
Curtain Plate 12"x.40" On Alt. Frames
6"x2½" Teak Rail
Plating .48"
Exposed Deck 5"x2½" Teak
Half Beams in way of Casings 10"x3½"x.50" B.A. on ev. Fr.
Knees 30"x.50" 7-⅞" Rivs.
53¼"x.80"x.10" Compensation for 14" Sidelights
14" Sidelights
Two Stringers, - Outer 55 15/16"x.52" Inner 49 5/16"x.52"
Plating .44"
Half Beams in way of Casings 10"x3½"x.50" B.A. ev. Fr.
Knees 30"x.50" 7-⅞" Rivs.
Sidelights 16",14",12",10" Dia.
Funnel Casing 9'6⅜" over Coaming
Stringer 53½"x.46"
Plating .38"
Half Beams in way of Casings 10"x3½"x.50" B.A. every Fr.
Knees 30"x.50" 7-⅞" Rivets
Half Beams in way of Casings 10"x3½"x.58" B.A. ev. Fr.
Stringer 52¾"x.46"
Stiffeners 4½"x3"x.52" on Alt. Frs.
Plating Flanged 4" Deep on Intermediate Frs.
Knees 31"x.54" 7-⅞" Rivs.
4½"x3"x.52" Single Pillar on Frames 96,98,102,104,106,110,112,114,118,120
Plate Brackets on Frs. 100 & 116
Bracket 24"x22"x.40"
Tie Pl. 22"x.46"
Stringer 41"x.46"
Beams 12"x3½"x.64" B.A. on Alt. Fr.
.50" Knee 27"x27"
Knee 31"x.60" 9-⅞" Rivets
Stiffeners 10"x3½"x.58" B.A. on Alt. Fr.
Additional Intercostals in Engine Room.
Frames in Double Bottom Doubled from Margin to Margin, from ¾L Ford to Collison Bhd.
Additional Int'l. Girders, ½ Depth of Center Girder, fitted Ford of ¾L to extend as far Forward as Practicable
Tank Top Plating-Center Strake 50"x.58"-.46", in B.R. .62"
" " " in Engine Room .58". Remainder .48"-.42"
Loges Single Riveted except in M.L. Strake
Center Girders 50"x.64"-.50"
Floors .54" in B.R. on ev. Fr.
Keel Plate 52"x1.28", ¾L-.88"
Butts Double Strapped, Treble Riveted throughout
Drains 2"x⅞" in Boiler Spaces
Thickness of Side Plating includes Compensation for Omission of Side Stringers
37'-0" Molded Depth to Upper Deck

Fig. 7.—Midship Section

Passenger and Cargo Steamer Oropesa

General Information

Service: Passenger and Freight, New York, Cherbourg, Southampton.

Builder: Cammell Laird & Co., Ltd., Birkenhead, England.

Owner: Pacific Steam Navigation Company, London, England.

Characteristics

Length, overall	552'-0"
Length, B. P.	530'-0"
Breadth, molded	66'-0"
Depth, molded, shelter deck	45'-0"
Draft, loaded	28'-0"
Draft, light	
Block coefficient	0.82
Midship section coefficient	
Longitudinal coefficient	
Speed, loaded, knots	14.5
Cruising radius, nautical miles	
Framing	Transverse
Class	100A-1 Lloyds

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull	
**Weight Propelling Machinery	
Deadweight Capacity	
Displacement	24,000

(In tons of 100 cubic feet)

Gross register	14,500
Net register	

*Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

**Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

2 Bower anchors, stockless, each	113 cwts.
1 Bower anchor, stockless	97 cwts.
1 Stream anchor, ex-stock	34 cwts.
1 Kedge anchor, ex-stock	18 cwts.
Chain cable, 2-15/16" stud link	330 fms.
Stream line, 1-11/16" stud link	150 fms.
Towline, 7" steel wire	130 fms.
Hawsers and warps	
4 lengths 3" steel wire, each	120 fms.
4 lengths 8" manila, each	120 fms.

Rudder

Area	
Dia. Stock	
C. Press. abaft C. L. pintles	

Complement

Deck officers	7
Deck crew	58
Engineer officers	7
Engineer crew	66
Purser's and steward's department	125
Total officers and crew	263
First-class passengers	143
Second-class passengers	131
Third-class passengers	366
Total passengers	640
Total complement	903

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		
Derrick posts	8	Steel		
Booms	18	Steel	5 Ton	
Booms	6	Steel	10 Ton	
Booms	8	Steel	3 Ton	

Deck Machinery

(Number, Size, Type)

Stering Gear	Steam gear of Brown Bros., Edinburgh.
Windlass	Steam
Capstans	2
Winches, cargo, 11	8"x12"
Winches, boat, 4	8"x12"

Life Saving Equipment

	No.	No. of Persons	Length
Lifeboats	8	52	27'-3"
Lifeboats	2	51	27'-3"
Lifeboats	5	62	28'-0"
Lifeboats	2	20	20'-0"
Boats, motor	2	30	30'-0"

Propelling Machinery

Boilers

Number	4
Type	Double-ended Scotch
Length	
Width or Diameter	
Furnaces, each boiler	8
Fuel	Coal
Draft	Natural
Total heating surface, square feet	
Total grate surface or furnace volume	
Superheat, degrees F	
Working pressure, lbs. per sq. in.	190
Normal fuel consumption:	
Per day, tons	
Per horsepower hour, pounds	
Normal steam production:	
Per hour per pound of fuel	lbs.
Total per hour	lbs.

Engines

Number	2 sets steam turbines
Type	Parsons's double reduction geared
Size	
Horsepower	

Propellers

Number	2
Type	3 bladed—built up
Weight	
Diameter	
Pitch	
R. P. M.	95
Projected area	
Developed area	

Auxiliary Machinery

(Number, Size, Type)

Machinery Space

Condensers

Evaporators

Distiller

Filters

Feed water heater

Fuel oil heaters

Pumps

Refrigerating Machinery

Electric Equipment

Generators....Three 60 k.w.-100 volt steam driven.

Radio .....Marconi installation

Emergency..One 33 k. w.-100 volt paraffin driven.

Holds

No.	Length	Hatches
1	63'-0"	15'-9" x 16'-0"
2	61'-0"	25'-0" x 16'-0"
3	70'-0"	12'-6" x 16'-0"
4	65'-0"	17'-6" x 16'-0"
5	52'-6"	17'-6" x 16'-0"
6	50'-0"	15'-0" x 16'-0"

Capacities

Cargo Space

Compartment	
Hold No. 1	
" " 2	
" " 3	
" " 4	
" " 5	
" " 6	
Lower 'tween decks	
Frs. 177-205	
" 152-177	
Main 'tween decks	
Frs. 193-205 special cargo	
" 177-193	
" 168-177 special cargo	
" 152-168	
" 124-152	
" 47 - 52 special cargo	
" 38 - 47	
" 31 - 38 specie room	
" 11 - 20 special cargo	

Refrigerated Space

Compartment	Cu. Ft.
Refrigerated chambers & dry stores	14,000

Bunkers

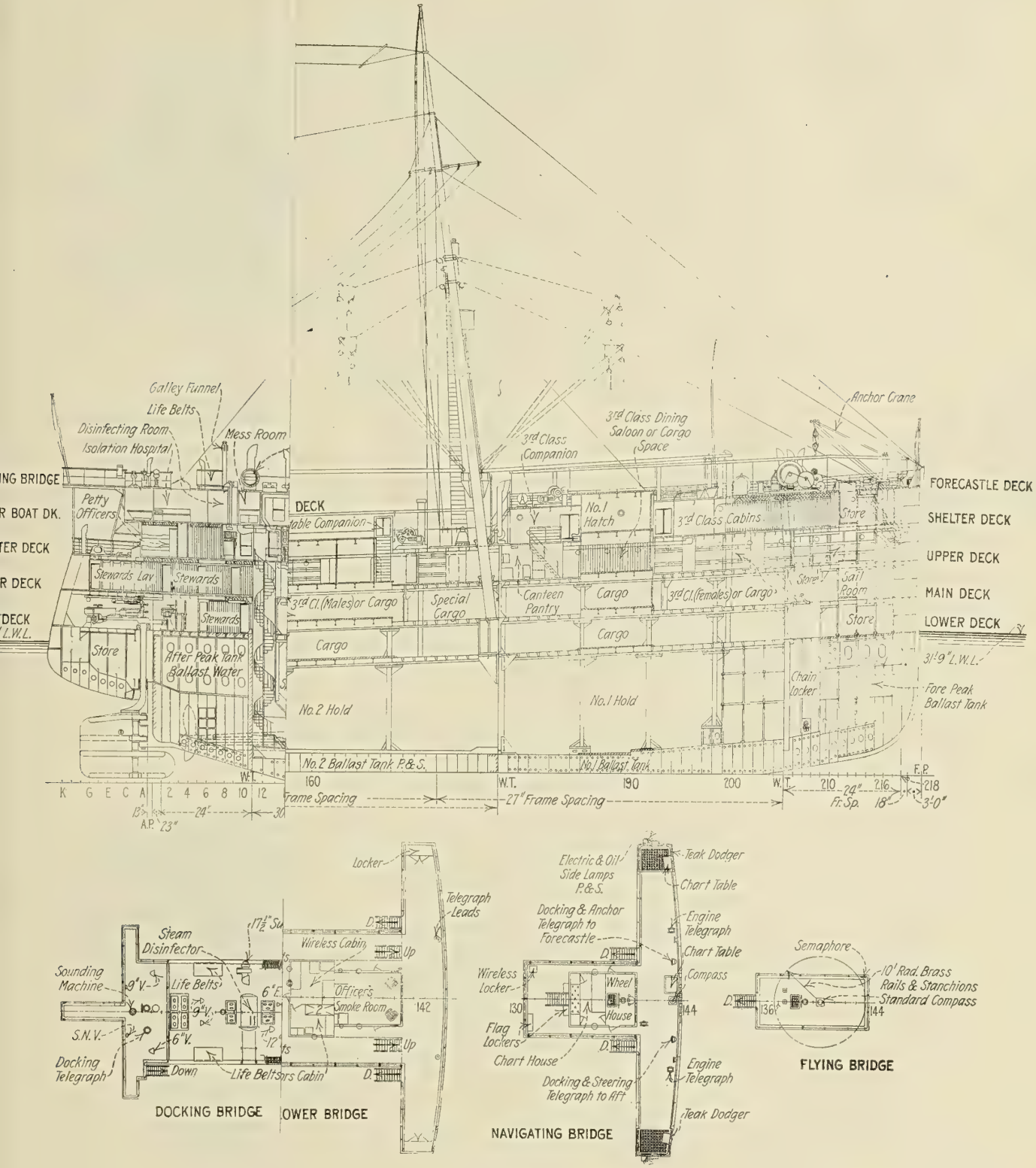
Compartment	Cu. Ft.	*Bbls.	*Tons
Port Hold Bunkers			
Star. Hold Bunkers			
Port 'Tween Deck Bunkers			
Star. 'Tween Deck Bunkers			

*....cu. ft. per ton;.....gals, per bbl.

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fore Peak Ballast			
No. 1 Ballast			
No. 2 Ballast, P. & S.			
No. 3 Ballast, P. & S.			
No. 4 Fresh Water, P. & S.			
No. 5 Fresh Water, P. & S.			
No. 6 Ballast, P. & S.			
No. 7 Reserve Feed, P. & S.			
No. 8 Ballast, P. & S.			
No. 9 Ballast			
After Peak Ballast			
F. W., Frs. 46-52 between tunnels			
F. W., Frs. 31-52 at side of tunnels			
Total			

A


Galley Funnel
Life Belts
Disinfecting Room
Isolation Hospital
Mess Room
Petty Officers
DECK
Table Companion
Stewards Lav
Stewards
Stewards
Store
After Peak Tank Ballast Water
3rd Class Companion
3rd Class Dining Saloon or Cargo Space
Anchor Crane
No.1 Hatch
3rd Class Cabins
Store
Store
Sail Room
Store
3rd Cl.(Males)or Cargo
Special Cargo
Canteen Pantry
Cargo
3rd Cl.(females)or Cargo
Cargo
Cargo
Chain Locker
No.2 Hold
No.1 Hold
Fore Peak Ballast Tank
No.2 Ballast Tank P.&S.
No.1 Ballast Tank
FORECASTLE DECK
SHELTER DECK
UPPER DECK
MAIN DECK
LOWER DECK
3'-9" L.W.L.
W.T.
160
190
200
210
216
218
F.P
24"
Fr. Sp.
18"
3'-0"
Frame Spacing
27" Frame Spacing
A.P.
23"
Locker
Telegraph Leads
Steam Disinfector
Wireless Cabin
Sounding Machine
Life Belts
Officer's Smoke Room
142
S.N.V.
Docking Telegraph
Down
Life Belts
Up
DOCKING BRIDGE
LOWER BRIDGE
Electric & Oil Side Lamps P.&S.
Teak Dodger
Chart Table
Docking & Anchor Telegraph to Forecastle
Engine Telegraph
Chart Table
Compass
Wireless Locker
Wheel House
130
144
Flag Lockers
Chart House
Docking & Steering Telegraph to Aft
Engine Telegraph
Teak Dodger
NAVIGATING BRIDGE
Semaphore
10' Rad. Brass Rails & Stanchions
Standard Compass
136
144
FLYING BRIDGE
Trimming Hatch
9" E.V.
9" S.V.
W.T.

PASSENGER AND CARGO STEAMER OROPESA

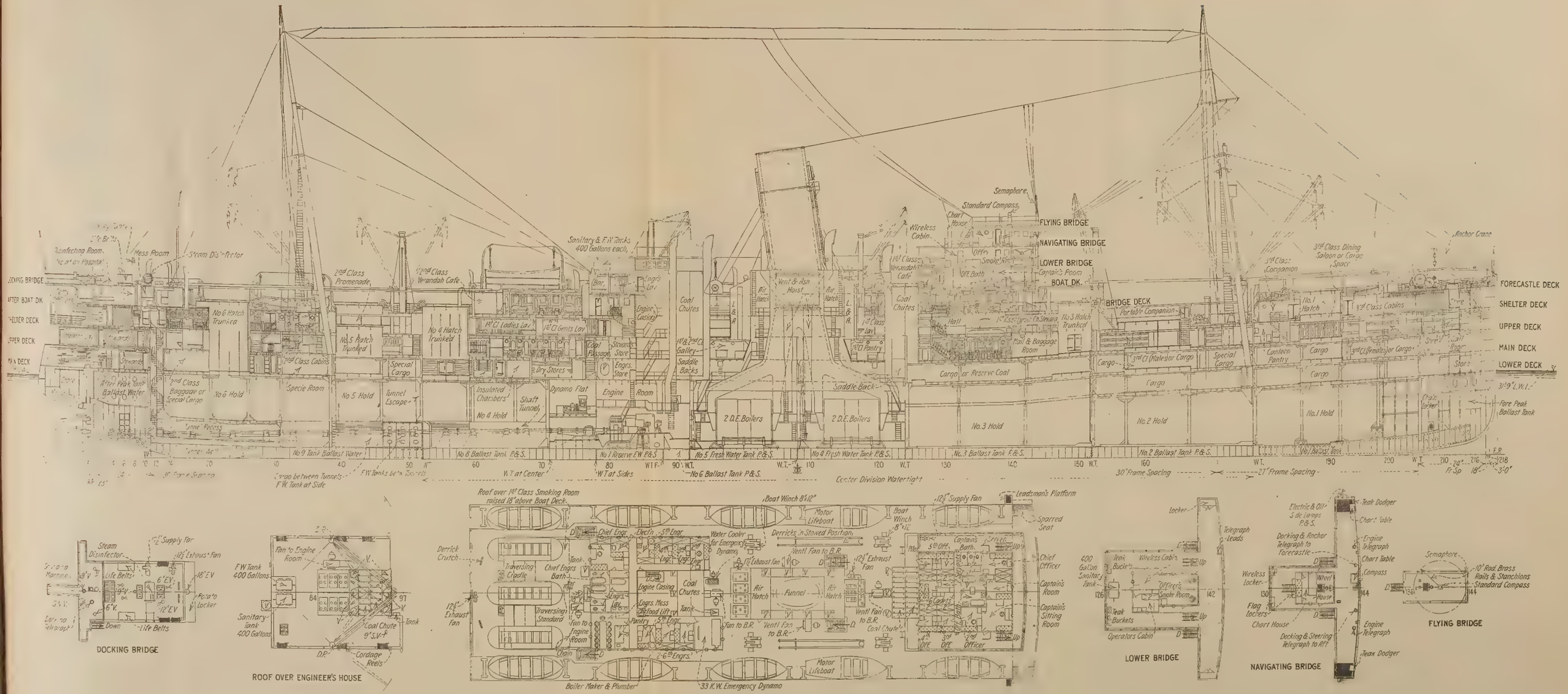


Fig. 8.—Profile and Upper Decks

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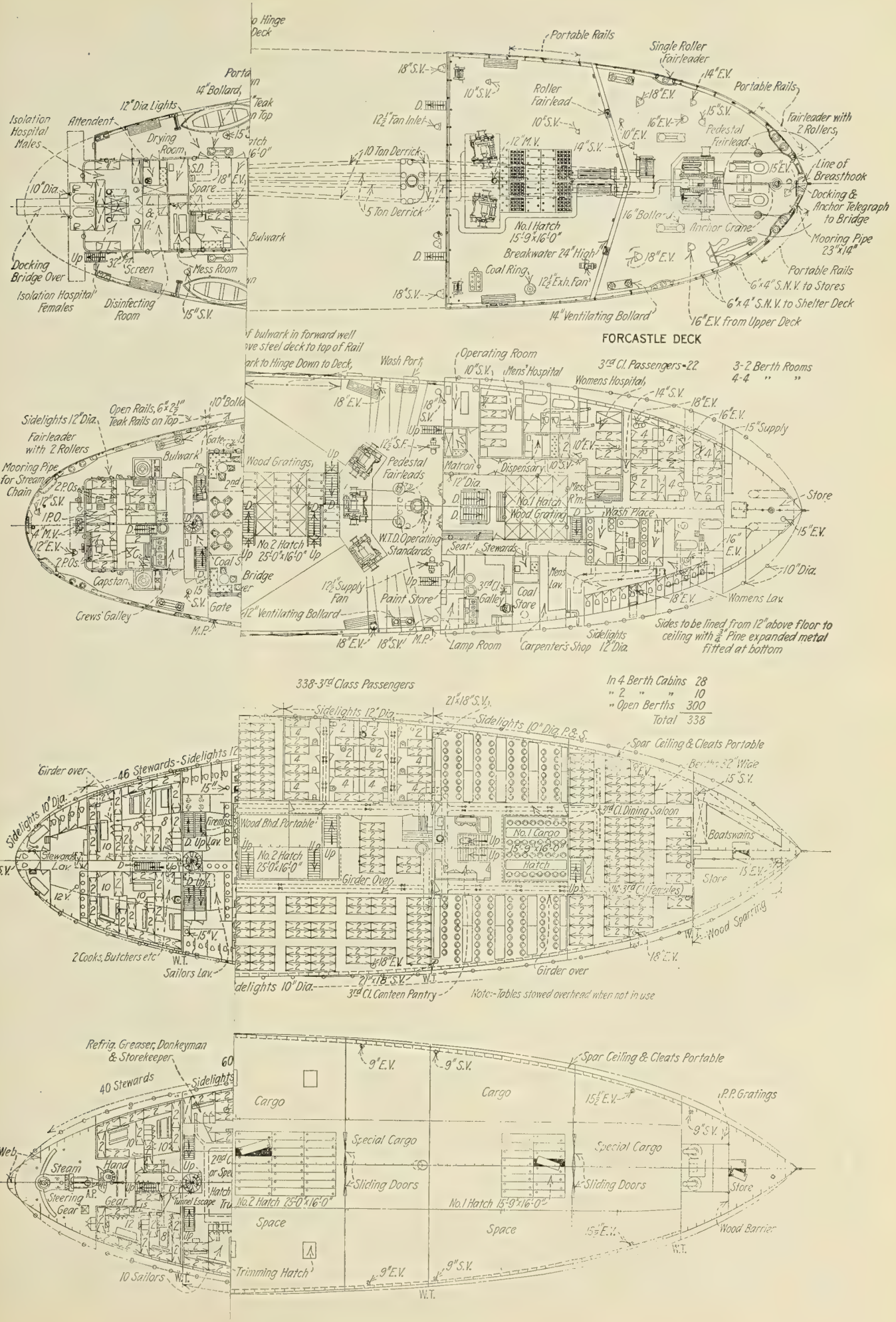

FORCASTLE DECK
Portable Rails
Single Roller Fairleader
Roller Fairlead
Pedestal Fairlead
Fairleader with 2 Rollers
Line of Breasthook
Docking & Anchor Telegraph to Bridge
Mooring Pipe 23"x14"
Portable Rails
6"x4" S.N.V. to Stores
6"x4" S.N.V. to Shelter Deck
16" E.V. from Upper Deck
14" Ventilating Bollard
10 Ton Derrick
5 Ton Derrick
No.1 Hatch 15'-9"x16'-0"
Breakwater 24" High
Coal Ring
Anchor Crane
16" Bollard
Isolation Hospital Males
Attendent
Drying Room
Isolation Hospital Females
Disinfecting Room
Mess Room
Screen
Docking Bridge Over
Bulwark
Wash Port
Operating Room
Mens Hospital
Womens Hospital
3rd Cl. Passengers-22
3-2 Berth Rooms
4-4 " "
Sidelights 12" Dia.
Open Rails, 6"x2½" Teak Rails on Top
Fairleader with 2 Rollers
Mooring Pipe for Stream Chain
Wood Gratings
Pedestal Fairleads
Matron
Dispensary
Mess Rm.
Wash Place
Store
No.1 Hatch Wood Grating
No.2 Hatch 25'-0"x16'-0"
W.T.D. Operating Standards
Seat
Stewards
Capstan
Coal S.
Bridge
Crews' Galley
Gate
Paint Store
3rd Cl. Galley
Coal Store
Womens Lav.
Mens Lav.
Lamp Room
Carpenter's Shop
Sides to be lined from 12" above floor to ceiling with ¾" Pine expanded metal fitted at bottom
338-3rd Class Passengers
In 4 Berth Cabins 28
" 2 " " 10
" Open Berths 300
Total 338
Sidelights 12" Dia.
Sidelights 10" Dia. P.&S.
Spar Ceiling & Cleats Portable
Girder over
46 Stewards
Sidelights 10" Dia.
Wood Bhd. Portable
No.1 Cargo Hatch
3rd Cl. Dining Saloon
Boatswains Store
Stewards Lav.
No.2 Hatch 25'-0"x16'-0"
Girder Over
Wood Sparring
2 Cooks, Butchers etc
Sailors Lav.
3rd Cl. Canteen Pantry
Note:-Tables stowed overhead when not in use
Refrig. Greaser, Donkeyman & Storekeeper
40 Stewards
Cargo
Special Cargo
Sliding Doors
Space
Trimming Hatch
Steam Steering Gear
Hand Gear
Web
10 Sailors
Tunnel Escape
Wood Barrier
W.T.

PASSENGER AND CARGO STEAMER OROPESA

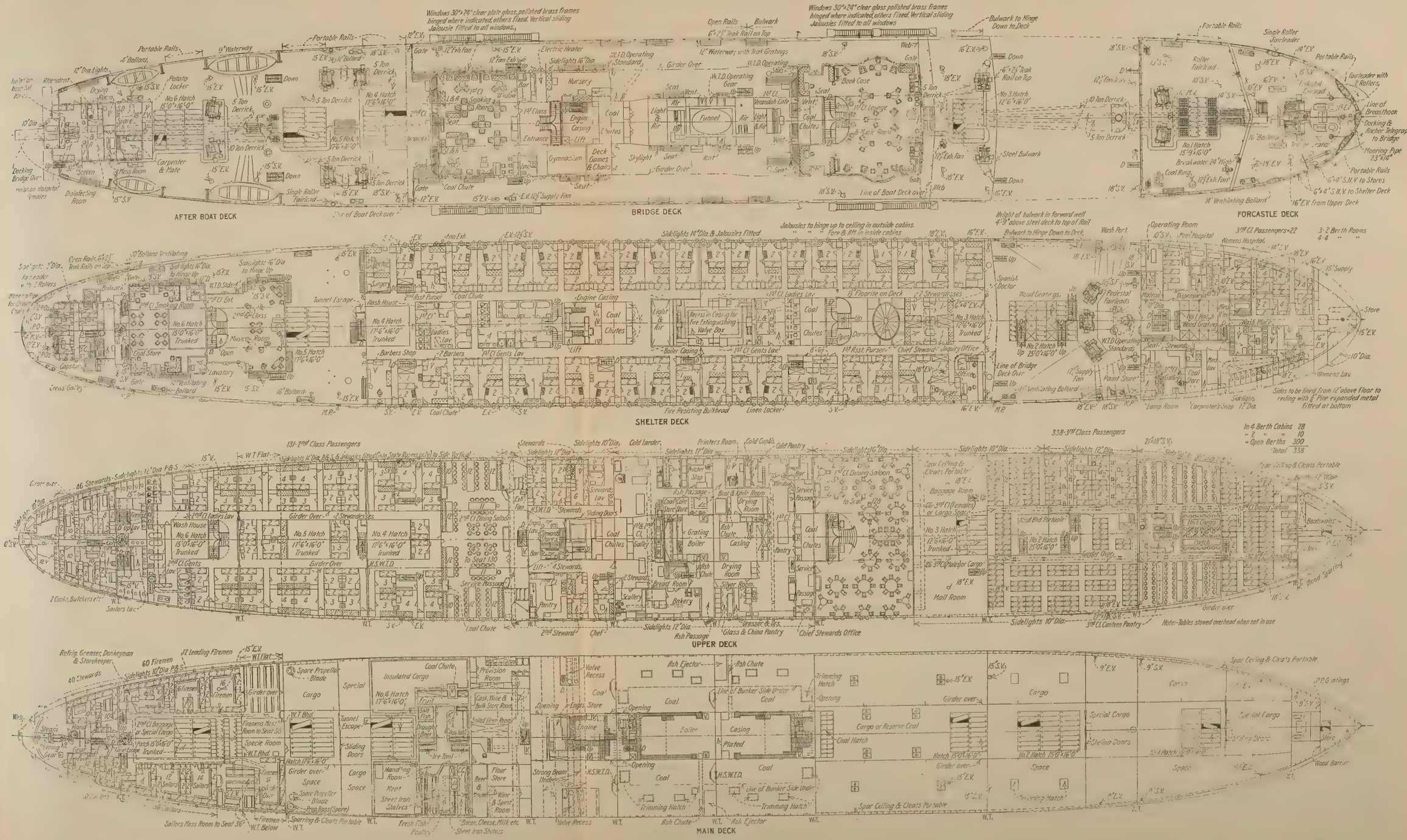


Fig. 9.—Deck Plans

At the aft end of the lounge is the first class veranda, fitted out in the usual manner with teak seats, tables, etc.

The first class smoking room, located amidships on the bridge deck, is a spacious room with raised ceiling. The ceiling is covered with fibrous plaster and the walls are framed in oak and panelled. The furniture is arranged in an attractive manner and comprises circular and square top tables, elbow chairs, settees, etc. The floor is laid with Rublino tiles to tone with the general effect.

Adjoining the smoking room is a nursery on the port side and a gymnasium on the starboard, each well fitted out with the usual appliances.

First class passengers are berthed on the shelter deck amidships. The staterooms are framed in panelled pine and are enameled white. Single berth cabins with cot beds are a feature of this accommodation.

Forward on the upper deck is the first class dining saloon with seating accommodation for 128. Over the dining saloon is a large ornamental dome. The furniture is well arranged, and the walls are framed in light oak to special design. The panelled ceiling is of fibrous plaster finished in white enamel relieved with gold and the floor is laid with Rublino tiles.

The midship portion of the upper deck is taken up by the saloon galleys and pantries equipped with all the latest appliances.

Second Class

On the bridge deck aft of the first class smoking room is situated the second class veranda with seats and tables.

At the aft end of the shelter deck is the second class smoking room and second class music room. The walls of the former are framed in oak, while the ceiling is covered with venesta neatly ornamented and the floor with Rublino tiles. The second class music room adjoining is decorated in mahogany with distinctive carvings and moldings. The ceiling of this room is also covered with ornamented venesta, and finished in white with gold relief, the floor being also laid with Rublino tiles.

Aft of the galleys and pantries on the upper deck is situated the second class dining saloon with a seating accommodation of 130. The furniture in this saloon is in polished mahogany. The walls are panelled in hardwood and finished in white enamel.

Second class passengers are berthed in staterooms at the after end of the upper deck. The staterooms are framed in panelled pine and enamelled white.

Third Class

Third class passengers are berthed in staterooms under the forecastle and upper decks and in open berths at the forward end of the upper deck.

The third class dining saloon, situated forward on the upper deck, has a seating accommodation of 160, and is furnished in a plain but substantial manner.

Under the forecastle is a well fitted galley for the service of the third class passengers and separate hospitals for men and women, with operating room attached. On the starboard side forward are situated the third class lavatories and bathrooms.

Crew Accommodations

Officers' accommodations are located on the boat deck, the captain and deck officers at the forward end and the engineers at the after end; complete with cabins, bathrooms, lavatories, etc.

The sailors and firemen are berthed aft.

Cargo Handling Gear

Cargo is handled by means of steel tubular derricks fitted to the masts and four special steel derrick posts, two forward and two aft, viz. two 10-ton and two 5-ton on the main mast, four 10-ton and four 5-ton on the fore mast, four 5-ton on each of the after posts, two 5-ton on each of the forward posts. The cargo is worked by eleven 8-inch by 12-inch winches substantially fastened to the deck by girders. A large specially designed crane is also fitted on the forecastle head for working the stockless anchors when required.

The coaling for the ship is done by means of large coaling hatches on the boat deck which extend to the bunkers and 'tween deck holds. Four steel derrick posts are fitted with two 3-ton steel tubular derricks attached to each for working the coal, power being supplied by the four 8-inch by 12-inch boat winches.

Life Saving Equipment

Lifeboats worked by Welin's patent davits are supplied with ample capacity to accommodate all persons on board should necessity arise. On the after end of the boat deck a number of these boats are stowed across the ship on a traversing cradle to enable their being shifted to either side of the vessel.

Main Propelling Machinery

Propulsion is by two sets of Parson's double reduction geared turbines of the latest improved type, driving twin screws. Each set of turbines consists of one high pressure, one intermediate and one low pressure turbine coupled to the main shaft by means of double reduction gearing, compound astern turbines of the impulse reaction type being incorporated in the intermediate and low pressure casings.

The propeller revolutions at full power will be about 95 per minute, while the turbine revolutions will be 3,500 per minute for the high pressure and intermediate turbines and 1,800 per minute for the low pressure turbines.

The main condensers are suspended from the low pressure turbines and are designed for a high vacuum.

Michell type main thrust blocks are provided.

The twin propellers have bosses of cast iron with separate blades of manganese bronze.

There are four double ended boilers of the cylindrical marine type working at a pressure of 190 pounds per square inch. Each boiler has eight furnaces and the boilers are designed for natural draft.

The installation is supplied with high class auxiliary machinery and the whole of the machinery has been built to the requirements of the Board of Trade and Lloyd's Registry of Shipping under the supervision of Mr. Lee Wood, the company's superintendent engineer.

Aft on the main deck is the steering compartment with a large hand and steam steering gear supplied by Brown Brothers of Edinburgh.

Marconi wireless is also fitted.

The vessel is fitted with a large steam windlass and at the after end of the shelter deck are two powerful warping capstans and two special fairleads for working the ship when going through the Panama Canal.

The whole ship is ventilated by natural methods assisted by high powered fans.

Electric light is provided throughout the vessel, the installation consisting of three 60 kilowatt 100 volt steam-driven dynamos. On the boat deck is a 33 kilowatt 100 volt paraffin-driven emergency dynamo, all to International Convention requirements.

New Service Begins This Month.—As one of the several developments among the various lines operating on the Atlantic, the Royal Mail Steam Packet Company will have its first eastbound sailing from New York early this month, when the *Orbita* sails for Liverpool. She will be followed by the *Oropesa* and *Orduna*. These steamers have been plying on the South American service of the Royal Mail and will be refitted for the more temperate zones.

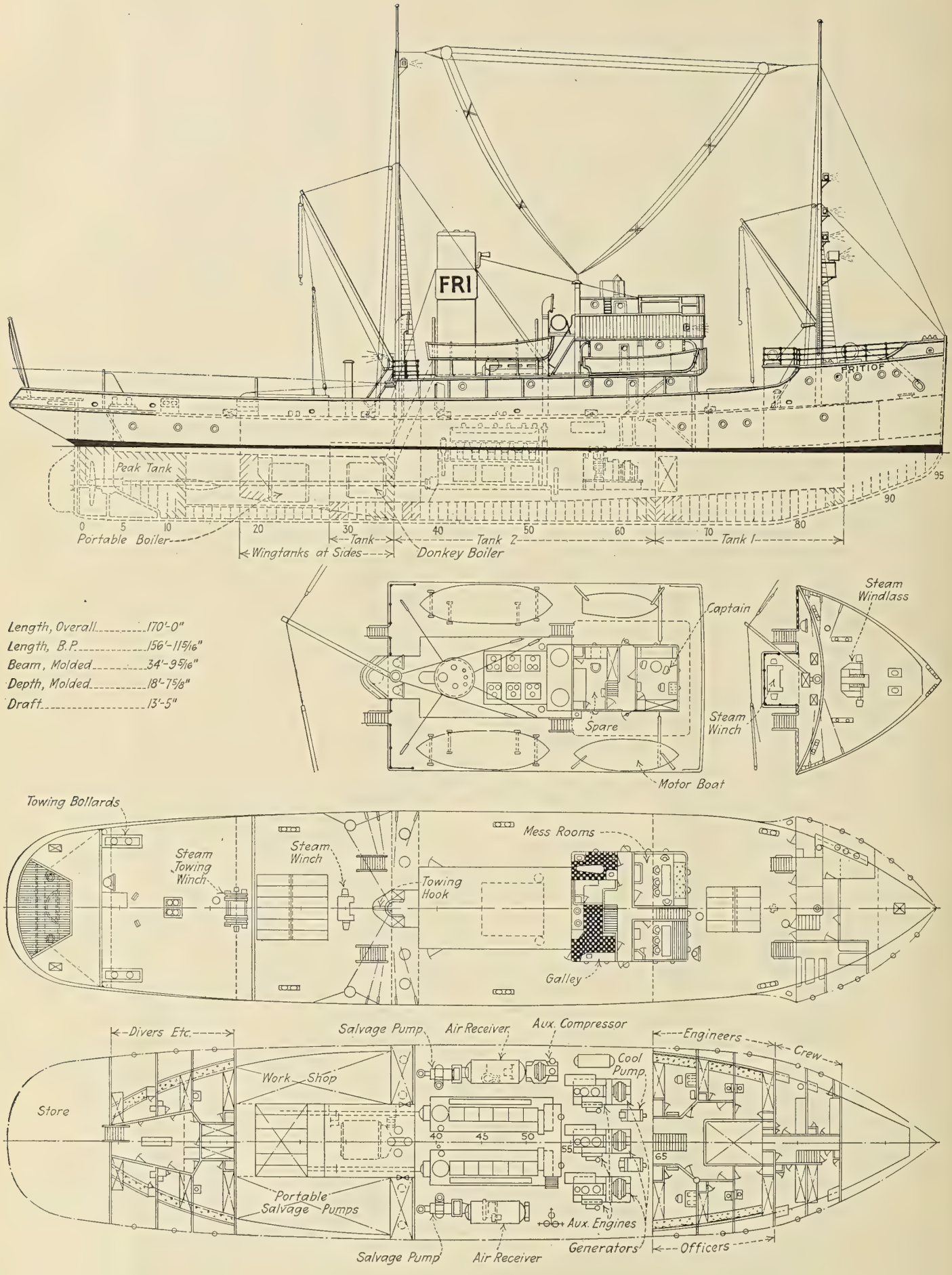


Fig. 1.—Profile and Deck Plans of Salvage Ship *Fritiof*

Salvage Motor Vessel Fritiof

New Type of Motorship Built in Sweden for the Gothenburg Towing and Salvage Company

A POWERFUL Diesel motor driven salvage ship has lately been built by the Götaverken, of Gothenburg, the biggest shipyard in Sweden, and handed over to its owners the Gothenburg Towing and Salvage Company.

In deciding upon Diesel propelling engines and Diesel-electric and electric-pneumatic auxiliary and salvage machinery, the owners took a bold step, as the *Fritiof* is equal to and probably superior in size and power to all existing steam driven salvage ships.

One valuable advantage of Diesel power for a salvage vessel is that in all cases of emergency she is ready for instant start, with a minimum of stand by charges, instead of having to keep steam up with its continuous consumption of coal or oil fuel. In addition the cruising radius of the ship is three to five times as large, thus allowing her to remain operating at the scene of a wreck for a much longer period without re-fueling.

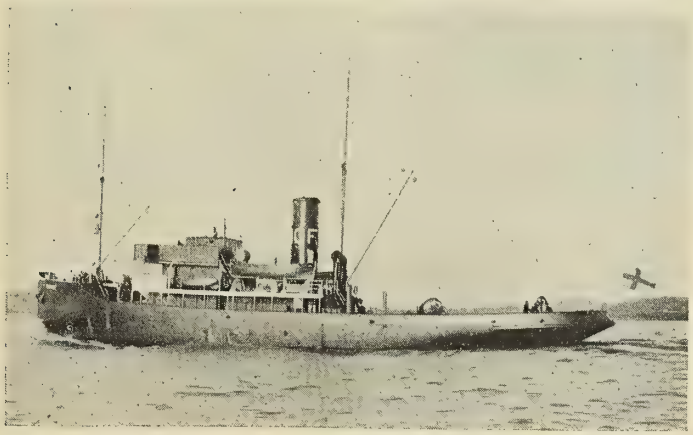


Fig. 2.—Swedish Salvage Ship *Fritiof*

Principal Dimensions

The principal dimensions of the *Fritiof* are as follows:

Length, overall	170 feet
Length, between perpendiculars	156 feet 11 5/16 inches
Breadth, molded	34 feet 9 5/16 inches
Depth, molded	18 feet 7⅝ inches
Draft, with 250 tons fuel and cargo	13 feet 5 inches
Horsepower, indicated	1,250

Main Propelling Machinery

The *Fritiof* is a twin screw ship propelled by two four cycle Burmeister and Wain type Götaverken-built Diesel engines, each with an output of 625 indicated horsepower from six cylinders 15.748-inch bore by 29.527-inch stroke at 150 revolutions per minute.

Auxiliary Machinery

In addition there are three 90 indicated horsepower Diesel engines coupled to electric generators which furnish current to the following electric motor-driven equipment:

2—16 inch salvage pumps in the engine room
3—8 inch portable salvage pumps
2 portable plunger pumps

The windlass, steering gear, two 5-ton winches and one 10-inch towing winch are steam driven and the rigging is designed for 10 tons lift.

There are also three 8-inch motor driven portable salvage pumps and one 12-inch steam driven salvage pump, the total capacity of all the pumps being 6,000 tons per hour.

General Arrangement

The general arrangement of the machinery and accommodations are illustrated by Fig. 1, the captain, spare room, mess room, galley and bath being located in a deck house amidships, the officers and crew under the deck forward and the divers and spare accommodation under the deck aft. There are good clear deck spaces for working the salving outfit and a hold aft for a portable boiler and workshop, also a roomy hold forward.

Not only the builders, Götaverken, but also the owners are confident that this new ship will prove a success. The first trip of the vessel, towing a 7,000-ton floating dock across the Baltic sea with a speed of 6 to 7 knots, showed that she was able to develop more power than anticipated.

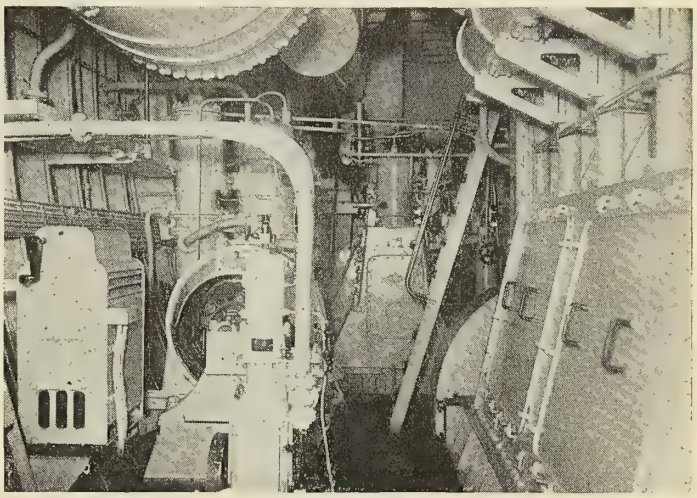


Fig. 3.—Port Side of Engine Room, Looking Forward

The Gothenburg Towing and Salvage Company has a fleet of 25 tugs and steamers up to 700 indicated horsepower in addition to lighters and pontoons for salvage work. With the new Diesel boat in commission the company will be fully able to meet all demands in the way of salvage work on the coasts of Scandinavia as well as further away.

The steamship *Mirzapore*, which was launched recently from the Walker yard of Sir W. G. Armstrong Whitworth & Company, Ltd., is one of the standard cargo vessels purchased from the Shipping Controller by the Peninsular and Oriental Steam Navigation Company, Ltd.

The principal dimensions of the vessel are:

Length between perpendiculars	411 feet 6 inches
Breadth, molded	55 feet 6 inches
Depth, molded	38 feet 1½ inches
Gross tonnage	6,700 tons

The vessel is of the single deck type with shelter deck, poop and forecastle having a cruiser stern and constructed on the Isherwood system. The propelling machinery consists of a set of geared turbines manufactured by the Parsons Marine Steam Turbine Company, Ltd.

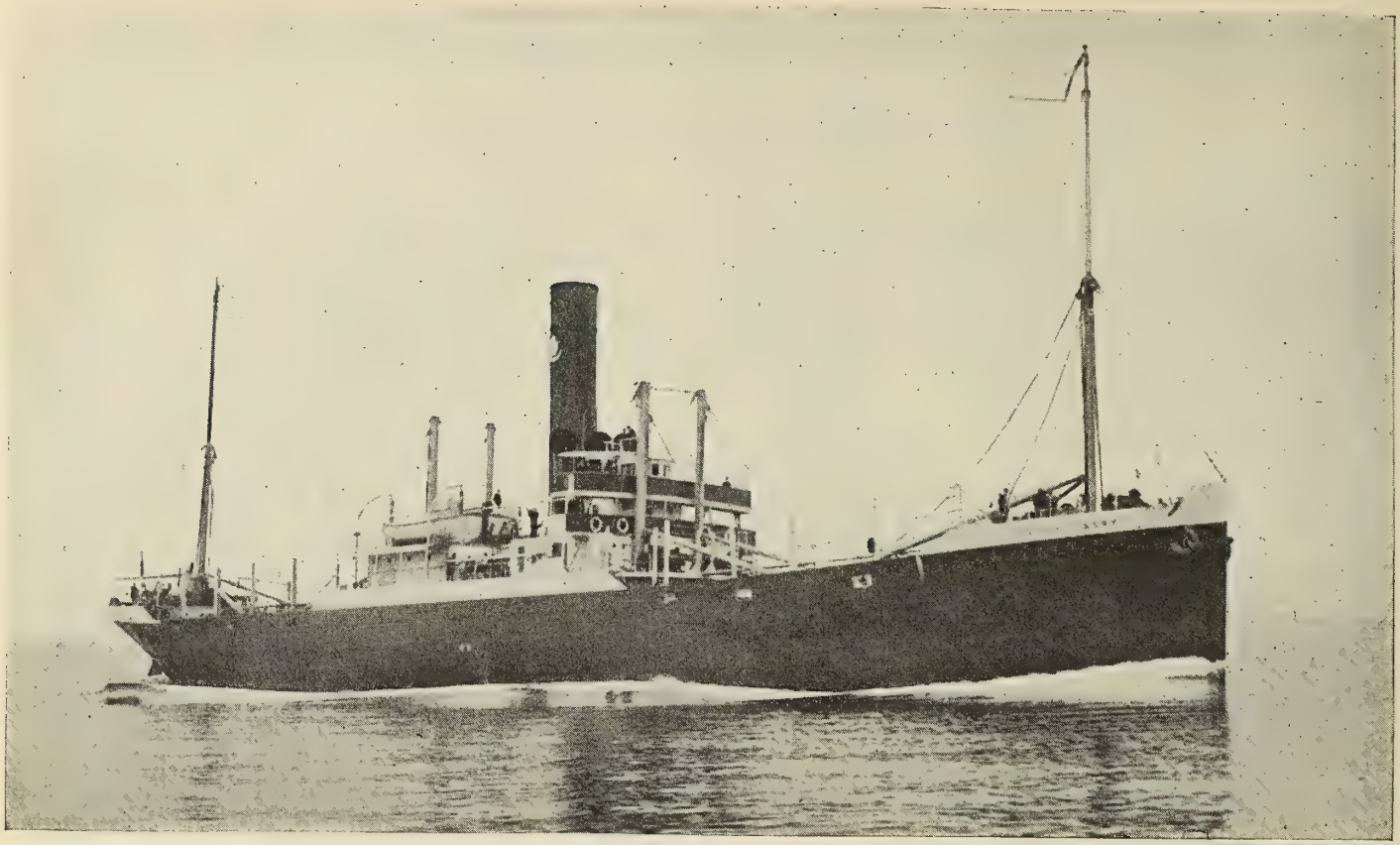


Fig. 1.—S. S. *Nelly Lasry*

Wine Steamers Nelly Lasry and Sidney Lasry

4,000 Deadweight Ton Vessels Specially Designed to Meet the Requirements of the French Wine Trade

THERE follows a description of the steamships *Nelly Lasry* and *Sydney Lasry,* specially designed and built for service in the French wine trade by The Burntisland Shipbuilding Company, Ltd., Burntisland, Fife, Scotland, to the account of Monsieur Joseph Lasry, of Oran and Paris.

The vessels are of the two deck type, with machinery space amidships, and have been built under Lloyd's special survey and classed 100 A-1*, also in accordance with French law.

While special attention has been given to the structural arrangements with a view to the fabrication of parts and speedy construction, the height for holds and 'tween decks, built pillars, depth of beams and knees, etc., have been arranged for the easy stowage of wine barrels in tiers.

It will be observed from Fig. 2 that the number and location of the winches and derricks, together with large, clear hatchways, are such as to provide for quick loading and discharging of cargo. In order to leave the wells clear of all obstructions the winches, masts and derrick posts are arranged on the poop, bridge and forecastle decks with fore and aft gangways fitted between these erections. This, together with a system of deck cargo supports and wires, provides a clear space for the stowage of wine barrels or other deck cargoes.

There are two cargo holds and one 'tween decks forward of the machinery space and one large cargo hold, divided into two by a wooden bulkhead, and one 'tween decks aft.

Four steel watertight bulkheads to the upper deck are provided and one steel watertight bulkhead to second deck dividing Nos. 1 and 2 holds.

Water ballast is carried in the double bottom and peak tanks, with the exception of the engine room tank, which is arranged for fresh water only, and the boiler room tank, which is a dry tank.

Tonnage openings are arranged in the after end bulkhead of the bridge, while the forecastle is permanently open, the bridge and forecastle 'tween decks being thus exempt from tonnage measurement.

There are four large cargo hatchways through the upper deck, each 27 feet long by 18 feet wide, with coamings 3 feet high and four hatchways of similar dimensions, but with angle coamings arranged in second deck. In addition, a trunked hatch 4 feet 6 inches long by 12 feet wide passes through the bridge deck and saloon house, and immediately below, in the upper and second decks, are additional hatches 6 feet 9 inches long by 18 feet wide.

Permanent coal bunkers are built at the port and starboard sides of the machinery space, and a coal chute is arranged through the boiler casing opening into the bridge 'tween decks, in which additional coal may be carried when necessary. The side bunkers are fed through bunker hatches 15 feet 6 inches long by 3 feet wide in the upper deck, with smaller hatches 4 feet 3 inches long by 3 feet wide arranged immediately above on the bridge deck.

Accommodations

The saloon and owner's cabin are arranged in a large steel deck house at the fore end of the bridge deck. On top of the saloon house is another house containing the captain's day and night cabin, while above on the flying bridge there is a steel house containing the chart room and wheel house.

E.

Awning
Ridge
Store
Aft Peak
Water Ballast
L.W.L.
Capacity
42 Tons
Cement

Fro

Panama
Fairlead
Panama
Fairlead

2½" At

One
Shelf

WINE STEAMERS NELLY LASRY AND SIDNEY LASRY

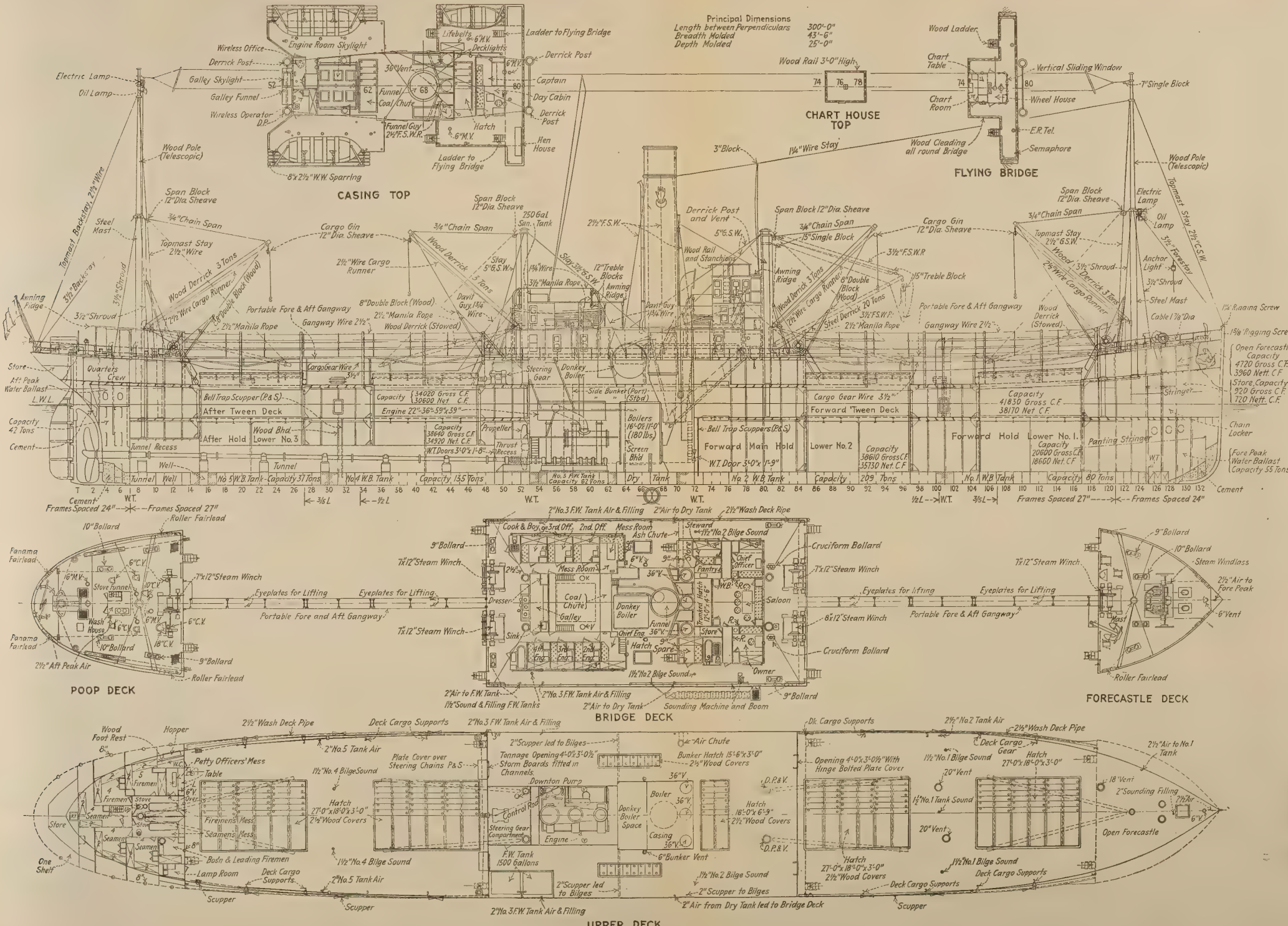
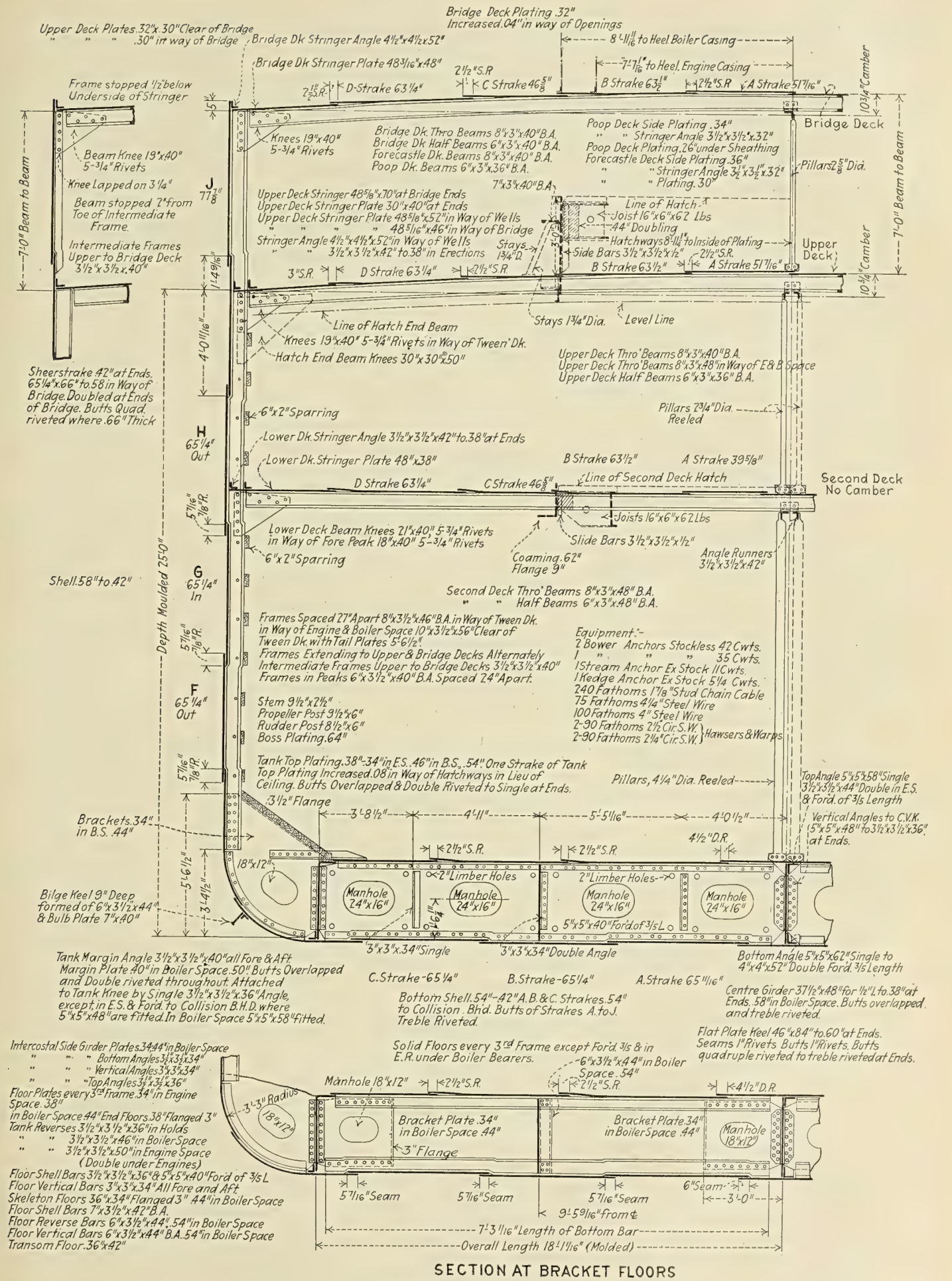


Fig. 2.—Profile and Deck Plans


Bridge Deck Plating .32" Increased .04" in way of Openings
Upper Deck Plates .32" x .30" Clear of Bridge
" " " .30" in way of Bridge
Bridge Dk Stringer Angle 4½"x4½"x.52"
8'-11 11/16" to Heel Boiler Casing
Bridge Dk Stringer Plate 48 3/16"x48"
7'-7 1/16" to Heel Engine Casing
2½" S.R
Frame stopped ½" below Underside of Stringer
2½" S.R.
D Strake 63¼"
C Strake 46 5/8"
B Strake 63½"
2½" S.R
A Strake 51 7/16"
10¾" Camber
Bridge Deck
Knees 19"x40" 5-¾" Rivets
Bridge Dk Thro Beams 8"x3"x40" B.A.
Bridge Dk Half Beams 6"x3"x40" B.A.
Forecastle Dk. Beams 8"x3"x40" B.A.
Poop Dk. Beams 6"x3"x36" B.A.
Poop Deck Side Plating .34"
" " Stringer Angle 3½"x3½"x.32"
Poop Deck Plating .26" under Sheathing
Forecastle Deck Side Plating .36"
" " Stringer Angle 3½"x3½"x.32"
" " Plating .30"
Pillars 2 5/8" Dia.
7'-0" Beam to Beam
Beam Knee 19"x40" 5-¾" Rivets
Knee Lapped on 3¼"
Beam stopped 7" from Toe of Intermediate Frame.
Intermediate Frames Upper to Bridge Deck 3½"x3½"x.40"
J 77 7/8"
7"x3"x40" B.A.
Upper Deck Stringer 48 5/8"x.70" at Bridge Ends
Upper Deck Stringer Plate 30"x40" at Ends
Upper Deck Stringer Plate 48 5/8"x.52" in Way of Wells
" " " " 48 5/16"x.46" in Way of Bridge
Stringer Angle 4½"x4½"x.52" in Way of Wells
" " 3½"x3½"x.42" to .38" in Erections
Stays 1¾" D
Line of Hatch
Joist 16"x6"x62 Lbs
44" Doubling
Hatchways 8'-11¼" to Inside of Plating
Side Bars 3½"x3½"x½"
2½" S.R.
Upper Deck
3" S.R.
D Strake 63¼"
2½" S.R
B Strake 63½"
A Strake 51 7/16"
10¾" Camber
7'-0" Beam to Beam
1'-4 9/16"
Stays 1¾" Dia.
Level Line
Line of Hatch End Beam
Knees 19"x40" 5-¾" Rivets in Way of Tween Dk.
Hatch End Beam Knees 30"x30"x50"
4'-0 11/16"
Upper Deck Thro' Beams 8"x3"x40" B.A.
Upper Deck Thro' Beams 8"x3"x48" in Way of E & B Space
Upper Deck Half Beams 6"x3"x36" B.A.
Sheerstrake 42" at Ends. 65¼"x.66" to .58 in Way of Bridge. Doubled at Ends of Bridge. Butts Quad riveted where .66" Thick
6"x2" Sparring
Pillars 7¾" Dia. Reeled
H 65¼" Out
Lower Dk. Stringer Angle 3½"x3½"x.42" to .38" at Ends
Lower Dk. Stringer Plate 48"x.38"
B Strake 63½"
A Strake 39 5/8"
D Strake 63¼"
C Strake 46 5/8"
Line of Second Deck Hatch
Second Deck No Camber
5 7/16" R. 7/8" R.
Joists 16"x6"x62 Lbs
Lower Deck Beam Knees 21"x40" 5-¾" Rivets in Way of Fore Peak 18"x40" 5-¾" Rivets
Slide Bars 3½"x3½"x½"
6"x2" Sparring
Coaming .62" Flange 9"
Angle Runners 3½"x3½"x.42"
Depth Moulded 25'-0"
Shell .58" to .42"
G 65¼" In
Second Deck Thro' Beams 8"x3"x48" B.A.
" " Half Beams 6"x3"x.48" B.A.
Frames Spaced 27" Apart 8"x3½"x.46" B.A. in Way of Tween Dk.
in Way of Engine & Boiler Space 10"x3½"x.56" Clear of Tween Dk. with Tail Plates 5'-6½"
Frames Extending to Upper & Bridge Decks Alternately
Intermediate Frames Upper to Bridge Decks 3½"x3½"x.40"
Frames in Peaks 6"x3½"x.40" B.A. Spaced 24" Apart.
Equipment:-
2 Bower Anchors Stockless 42 Cwts.
1 " " " 35 Cwts.
1 Stream Anchor Ex Stock 11 Cwts.
1 Kedge Anchor Ex Stock 5¼ Cwts.
240 Fathoms 1 7/8" Stud Chain Cable
75 Fathoms 4¼" Steel Wire
100 Fathoms 4" Steel Wire
2-90 Fathoms 2½ Cir. S.W.
2-90 Fathoms 2¼" Cir. S.W.
Hawsers & Warps
F 65¼" Out
Stem 9½"x2½"
Propeller Post 9½"x6"
Rudder Post 8½"x6"
Boss Plating .64"
Tank Top Plating .38"-.34" in E.S., .46" in B.S., .54". One Strake of Tank Top Plating Increased .08" in Way of Hatchways in Lieu of Ceiling. Butts Overlapped & Double Riveted to Single at Ends.
Pillars, 4¼" Dia. Reeled
Top Angle 5"x5"x.58" Single 3½"x3½"x.44" Double in E.S. & Ford. of 3/5 Length
5 7/16" R. 7/8" R.
.3½" Flange
Brackets .34" in B.S. .44"
3'-8½"
4'-11"
5'-5 11/16"
4'-0½"
Vertical Angles to C.V.K. (5"x5"x.48" to 3½"x3½"x.36" at Ends.
4½" D.R.
2½" S.R.
2½" S.R.
18"x12"
2" Limber Holes
2" Limber Holes
5'-6½"
Manhole 24"x16"
Manhole 24"x16"
Manhole 24"x16"
Manhole 24"x16"
3'-1 4½"
Bilge Keel 9" Deep formed of 6"x3½"x.44" & Bulb Plate 7"x.40"
5"x5"x.40" Ford. of 3/5 L
3"x3"x.34" Single
3"x3"x.34" Double Angle
Tank Margin Angle 3½"x3½"x.40" all Fore & Aft
Margin Plate .40" in Boiler Space .50" Butts Overlapped and Double riveted throughout. Attached to Tank Knee by Single 3½"x3½"x.36" Angle, except in E.S. & Ford. to Collision B.H.D. where 5"x5"x.48" are fitted. In Boiler Space 5"x5"x.58" fitted.
Bottom Angle 5"x5"x.62" Single to 4"x4"x.52" Double Ford. 3/5 Length
C. Strake - 65¼"
B. Strake - 65¼"
A. Strake 65 11/16"
Bottom Shell .54"-.42" A.B. & C. Strakes .54" to Collision Bhd. Butts of Strakes A. to J. Treble Riveted.
Centre Girder 37½"x.48" for ½" L to .38" at Ends. .58" in Boiler Space. Butts overlapped and treble riveted.
Flat Plate Keel 46"x.84" to .60" at Ends. Seams 1" Rivets Butts 1" Rivets. Butts quadruple riveted to treble riveted at Ends.
Intercostal Side Girder Plates .34-.44" in Boiler Space
" " " Bottom Angles 3½"x3½"x.34"
" " " Vertical Angles 3½"x3½"x.34"
" " " Top Angles 3½"x3½"x.36"
Floor Plates every 3rd Frame .34" in Engine Space. .38" in Boiler Space .44" End Floors .38" Flanged 3"
Tank Reverses 3½"x3½"x.36" in Holds
" " 3½"x3½"x.46" in Boiler Space
" " 3½"x3½"x.50" in Engine Space (Double under Engines)
Floor Shell Bars 3½"x3½"x.36" & 5"x5"x.40" Ford of 3/5 L
Floor Vertical Bars 3"x3"x.34" All Fore and Aft
Skeleton Floors 36"x.34" Flanged 3" .44" in Boiler Space
Floor Shell Bars 7"x3½"x.42" B.A.
Floor Reverse Bars 6"x3½"x.44" .54" in Boiler Space
Floor Vertical Bars 6"x3½"x.44" B.A. .54" in Boiler Space
Transom Floor .36"x.42"
Solid Floors every 3rd Frame except Ford. 3/5 & in E.R. under Boiler Bearers.
6"x3½"x.44" in Boiler Space .54"
Manhole 18"x12"
2½" S.R.
2½" S.R.
4½" D.R.
3'-3" Radius
18"x12"
Bracket Plate .34" in Boiler Space .44"
3" Flange
Bracket Plate .34" in Boiler Space .44"
Manhole 18"x12"
5 7/16" Seam
5 7/16" Seam
5 7/16" Seam
6" Seam
3'-0"
9'-5 9/16" from ℄
7'-3 1/16" Length of Bottom Bar
Overall Length 18'-1 1/16" (Molded)

SECTION AT BRACKET FLOORS

Fig. 3.—Midship Section

Wine Steamers Nelly Lasry and Sidney Lasry

General Information

Service: French wine trade.

Builder: Burntisland Shipbuilding Company, Ltd., Fife, Scotland.

Owner: Mons. Joseph Lasry of Oran and Paris.

Characteristics

Length, overall	312'-6"
Length, B. P.	300'-0"
Breadth, molded	43'-6"
Depth, molded, upper deck	25'-0"
Draft, loaded	21'-0"
Draft, light	
Block coefficient	
Midship section coefficient	
Longitudinal coefficient	
Speed, loaded, knots	
Cruising radius, nautical miles	
Framing	Transverse

Class 100 A-1 Lloyd's special survey and in accordance with French law.

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull	
**Weight Propelling Machinery	
Deadweight Capacity	4,000
Displacement	

(In tons of 100 cubic feet)

Gross register	
Net register	

* Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

** Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

2 Bower anchors, stockless, each..42 cwts.
1 Bower anchor, stockless .....35½ cwts.
1 Stream anchor, ex-stock .....11 cwts.
1 Kedge anchor, ex-stock .....5¼ cwts.
240 Fms. 1⅞" stud chain cable.
75 Fms. 4¼" steel wire.
100 Fms. 4" steel wire.
2-90 Fms. 2½" steel wire.
2-90 Fms. 2¼" steel wire.

Rudder

Area	
Dia. Stock	
C. Press. abaft C. L. pintles	

Complement

Deck officers	4
Deck crew	14
Engineer officers	4
Engineer crew	10
Purser's and steward's department	3
Total officers and crew	37
First-class passengers	2
Second-class passengers	none
Third-class passengers	none
Total passengers	2
Total complement	39

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		
		Steel		
Derrick posts	4	Steel		
Booms	8	Wood	3 ton	
Booms	1	Steel	20 ton	

Deck Machinery

(Number, Size, Type)

Steering Gear steam	
Windlass, 1 steam	
Capstans	
Winches 5	7"x12" steam
1	8"x12" steam

Life Saving Equipment

	No.	Type	Length
Lifeboats	2		25'-0"
Dinghy	1		16'-0"

Propelling Machinery

Boilers

Number	2
Type	Scotch single-ended
Length	11'-0"
Diameter	16'-3"
Furnaces	
Fuel	Coal
Draft	Forced
Total heating surface, square feet	
Total grate surface or furnace volume	
Superheat, degrees F	
Working pressure, lbs. per sq. in.	180
Normal fuel consumption:	
Per day, tons	
Per horsepower hour, pounds	
Normal steam production:	
Per hour per pound of fuel	lbs.
Total per hour	lbs.

Engines

Number	1
Type reciprocating	triple expansion
Size	22"x36"x59"x39" stroke
Horsepower	

Propellers

Number	1
Type	
Weight	
Diameter	
Pitch	
R. P. M.	
Projected area	
Developed area	

Auxiliary Machinery

(Number, Size, Type)

Machinery Space

Condensers
Evaporators
Distiller
Filters
Feed water heater
Fuel oil heaters
Pumps

Refrigerating Machinery

Electric Equipment

Generators	
Radio	1½ k. w. Marconi
Emergency	

Holds

No.	Length	Hatches
1		27'-0" x 18'-0"
2		27'-0" x 18'-0"
		6'-9" x 18'-0"
		27'-0" x 18'-0"
3		27'-0" x 18'-0"

Capacities

Cargo Space

Compartment	Cu. Ft. Bulk	Cu. Ft. Bales
Hold No. 1	20,600	18,660
Hold No. 2	38,610	35,730
Hold No. 3	38,640	34,920
Forward 'tween decks	41,830	38,170
After 'tween decks	34,020	30,600
Open foc'sle	4,720	3,960
Store	920	720
Total	179,340	162,760

Refrigerated Space

Compartment	Cu. Ft.

Bunkers

Compartment	Cu. Ft.	*Bbls.	*Tons
Port side bunker			
Star. side bunker			
Port 'tween decks bunker			
Star. 'tween decks bunker			

*....cu. ft. per ton;.....gals. per bbl.

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fore peak tank			55
No. 1 tank			80
No. 2 tank			209
No. 3 tank		62	
No. 4 tank			135
No. 5 tank			37
After peak tank			42
Total		62	558

Engineers' and officers' accommodation is arranged in side houses abreast the engine casing, the engineers being berthed on the starboard side and the deck officers on the port side. The galley is arranged between these houses at the after end of the engine casing.

Commodious quarters for the crew are arranged in the poop, members being separated into cabins as far as possible for each watch. Separate mess rooms are provided in the poop for seamen and firemen, and on the deck above is arranged a steel entrance house containing also the washroom for the crew.

Fresh Water Tanks

Two fresh water tanks, each of 1,500 gallons capacity, are arranged at the after end of the bridge 'tween decks on the starboard side, these tanks being filled by means of a Worthington pump situated in the engine room and pumping from the engine room double bottom tank.

Hull

Special features have been introduced in the hull to facilitate construction and simplify the fabrication of parts. It will be noted that the bottom has no rise of floor, the bilge a 3-foot 3-inch radius, and the top sides no tumble home. The parallel middle body is carried well forward and aft without sheer, the sheer being confined to the endmost portions beyond the limits of this parallel body.

A standard rivet pitch of 3⅜ inches has been adopted throughout and the frame spacing, widths of strakes of plating and positions of tank girders have been arranged to suit this pitch. In the case of the side frame, beam, and tank connection bars the rivets are spaced alternately 3⅜ inches and 6¾ inches instead of the usual regular spacing, as the latter arrangements would not have conformed to the standard pitch required.

The heavy bulb angle side frames are all made on straight lines, extending from the upper turn of bilge to the upper or bridge deck alternately, and the variation of the angle at which these straight side frames were set in the case of the ends of the vessel was very carefully worked out with a view to producing a shipshape form.

Widths of shell plating are all equal and measured parallel on the run of the frame, thus permitting a standard template for frame riveting to be used. The frame holes being all worked off the standard template enables a short standard template to be used for marking off the shell plates.

Solid pillars are fitted and reeled to take shifting boards between the hatchways, a single built pillar in lieu of quarter pillars being fitted at hatch ends in conjunction with a deep-built hatch end beam. In way of the hatchways the hatch side coamings form longitudinal deck girders which transmit the loads to the strong transverse hatch end beams.

Steering Gear

The steam steering gear, which is controlled from the flying bridge, is placed in the after end of the engine casing at the upper deck level and controls a quadrant tiller on the rudder head by means of the usual arrangement of chains and rods.

There is also a hand screw steering gear mounted on the rudder head for emergency use.

The rudder is of the single plate type and is supported on a Taylor-Pallister patent rudder carrier. A Taylor-Pallister patent rudder brake is also fitted on the quadrant tiller.

Main Propelling Machinery

The propelling machinery, built by Messrs. Cooper & Greig, Ltd., of Dundee, Scotland, consists of one set of triple expansion engines having cylinders 22 inches, 36 inches and 59 inches in diameter by 39 inches stroke, and two single ended, forced draft, multitubular marine boilers 16 feet 3 inches external diameter by 11 feet mean length, which operate at 180 pounds per square inch working pressure.

For supplying steam for the deck machinery a donkey boiler 9 feet by 9 feet by 100 pounds per square inch working pressure is placed in the casing, at the upper deck level, just abaft the main funnel.

The vessel has an installation of electric lighting, steam heating to accommodation and ample ventilating and mooring arrangements.

A 1½-kilowatt Marconi wireless apparatus is installed, together with telescopic wood topmasts of sufficient height to give a radius of 250 miles by day.

Fire extinguishing pipes and connections are led to each hold, 'tween decks and bunkers in accordance with French law requirements.

These vessels were very successful during their measured mile progressive trials and four hours' continuous runs at sea, when in each case a speed of nearly 13 knots was obtained, this speed being well above that guaranteed by the builders.

The Geared Turbine Propelling Equipment of the New Shawmut Ships

AMONG the first ships to be contracted for and built by a private firm since the armistice are the *Mount Carroll,* launched on January 10, and her sister ship, the *Mount Clinton,* launched on February 8. Both were built at the Chester, Pa., yards of the Merchant Shipbuilding Corporation for the Shawmut Steamship Company, New York, and will be operated by the United American Lines, Inc., New York, between New York and Hamburg.

The general arrangement plans and a detailed description of these ships as they were originally designed for straight cargo carriers were published in the September, 1920, issue of Marine Engineering, but an interesting change was recently made in their construction owing to the great increase in the immigrant traffic to America. In order to carry this class of passengers westward, and at the same time avoid empty capacity on the eastward voyage, arrangements have been made whereby staterooms with two, four, and six standee berths and accommodating 1,500 people can be quickly erected in the two upper decks, and also be easily removed, leaving clear cargo space, when not needed. Another unique feature is the installation of a kitchen for kosher cooking in order to accommodate Jewish passengers.

These vessels are of the single-screw, shelter-deck type, with the propelling machinery located amidships. They were built and classed to the rules of Lloyd's Register of Shipping, 100A1, and in compliance with the regulations of the United States Steamboat Inspection service. Their principal dimensions are as follows:

Length overall	457 feet
Length between perpendiculars	440 feet
Beam, molded	57 feet
Depth at side to shelter deck	39 feet
Depth at side to upper deck	31 feet
Depth at side to lower deck	22 feet
Draft, designed load	28 feet 9 inches
Speed on designed load draft	13 knots
Deadweight, designed load draft	10,500 tons
Cargo capacity, bales	470,000 cubic feet
Fuel oil capacity at 38 cubic feet per ton	2,400 tons
Drinking water tanks	29 tons
Reserved feed water	150 tons

Propelling Machinery

Each ship is driven by a Westinghouse cross compound turbine, rated at 4,200 shaft horsepower and 3,600 revolutions per minute, and consisting of two elements—high pressure and low pressure—which drive the single propeller through a common gear. The high pressure element is of the impulse-reaction type, and the low pressure element of the pure-reaction type. Either element can be used independently in case of emergency. An astern turbine, of the

New Shawmut Passenger and Cargo Steamship *Mount Carroll*

impulse type, is incorporated in each element, and the two are arranged for compound operation.

The guaranteed steam consumption is 11.3 pounds per shaft horsepower hour, with dry saturated steam at 200 pounds pressure, and a vacuum of 28 inches. Superheat up to 50 degrees F. can also be used. Special nozzles, which permit an additional flow of steam, are provided so that full power can still be obtained in case either the pressure or the vacuum, or both, fall below normal. The astern turbines will develop 60 percent of the ahead power with full ahead steam flow.

A new form of governor, known as the oil-relay type, is used on these turbines. Its construction is of special interest because a new principle is employed. The steam supply is controlled by a valve which is maintained in its proper operating position by oil under pressure in the manner of the well-known hydraulic relay in combination with a floating lever. This relay is in turn controlled by the movement of a spring loaded valve, which is also controlled by oil under pressure. The pressure in this latter oil system is maintained by a centrifugal pump, mounted on the turbine shaft, and since this pressure varies directly with the speed of the turbine, a very sensitive speed control is obtained.

The gear is of the double reduction type and consists of two high speed gears, one for each turbine element, which drive a single slow speed gear connected directly to the propeller shaft. The speed reduction on the first step is from 3,600 to 520 revolutions per minute, and on the second step from 520 to 90 revolutions per minute.

The thrust bearing, which is an integral part of the slow speed gear, is of the latest Kingsbury type.

The main condenser has an area of 6,000 square feet and will condense 53,000 pounds of steam at 28.3 inches vacuum, with 70 degrees cooling water. Vacuum is maintained by means of air ejectors. The condenser is served by a 7,500-gallon per minute centrifugal circulating pump, driven by two turbines, which are so arranged that either may be used. The condensate is handled by two turbine driven pumps having a capacity of 140 gallons per minute each.

The auxiliary condenser has an area of 1,080 square feet. All of this apparatus is of Westinghouse make.

The *Mount Carroll* and *Mount Clinton* are the fourth and fifth Westinghouse-equipped ships to be owned by the Shawmut Steamship Company. Reports from the earlier vessels show that the gears and turbines with which they are equipped have given excellent service.

Ore and Coal Carriers Chilore and Lebore

20,700 Ton Deadweight Vessels Being Built by the Bethlehem Shipbuilding Corporation, Ltd., for the Ore Steamship Corporation

IN the description of the 20,500-ton deadweight, Bethlehem-Frear, combination ore and oil steamers *Marore* and *Steelore*, published in the April issue of MARINE ENGINEERING, it was stated that of six combination ore steamers under construction by the Bethlehem Company the last two, namely the *Chilore* and *Lebore*, were combination ore and coal carriers and that a description of the special features connected with their design would follow at an early date.

These two later vessels will be built at the Union Plant of the Bethlehem Shipbuilding Corporation at San Francisco and like their predecessors will be constructed on the longitudinal system of framing. With the exception of the design and construction of the holds, ballast and fuel tanks, cubic capacities, tonnage measurements, and slight increase in deadweight due to about 100 tons less steel, omission of steam-heating coils, reduced pumping capacity, etc., the description of the *Marore* and *Steelore* applies to these vessels and should be referred to if the reader desires a complete description of the quarters, decks, hatches, cargo handling gear, deck and propelling machinery, etc. For convenient reference, however, the full data compilations, corrected where necessary to make them applicable to these vessels, are reproduced.

Although the holds and tanks are of special design and construction, they are distributed over the same length of the vessel, thereby permitting the two ends to correspond exactly with those of the earlier vessels in details of construction. This resulted in great advantage, as many of the plans were thus common to both types of vessels.

Design Requirements

These vessels are to operate between New York or Baltimore and Cruz Grande, Chile, via the Panama Canal and will carry coal south and iron ore north.

In order to insure the greatest commercial success, it was

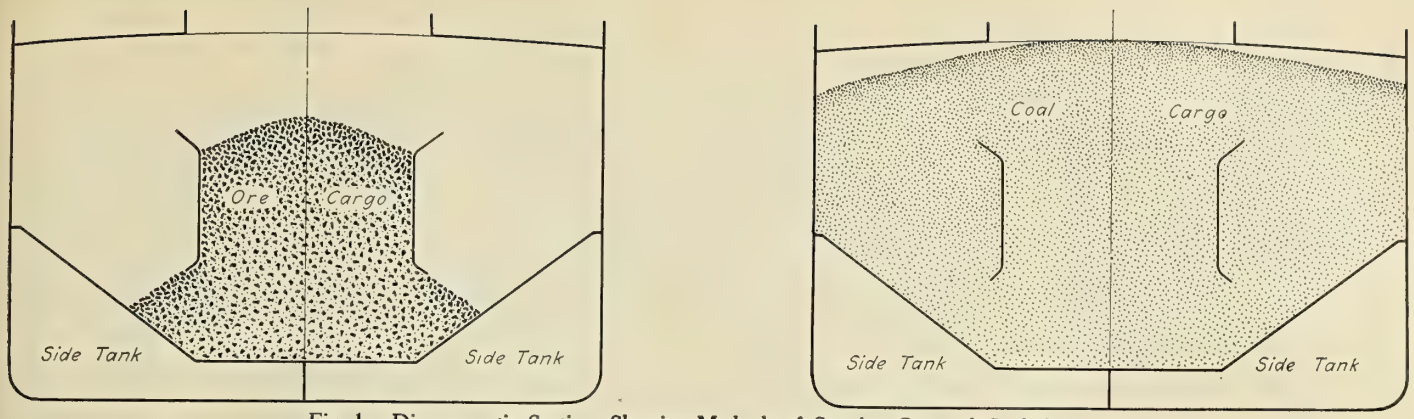


Fig. 1.—Diagrammatic Sections Showing Methods of Stowing Ore and Coal Cargoes

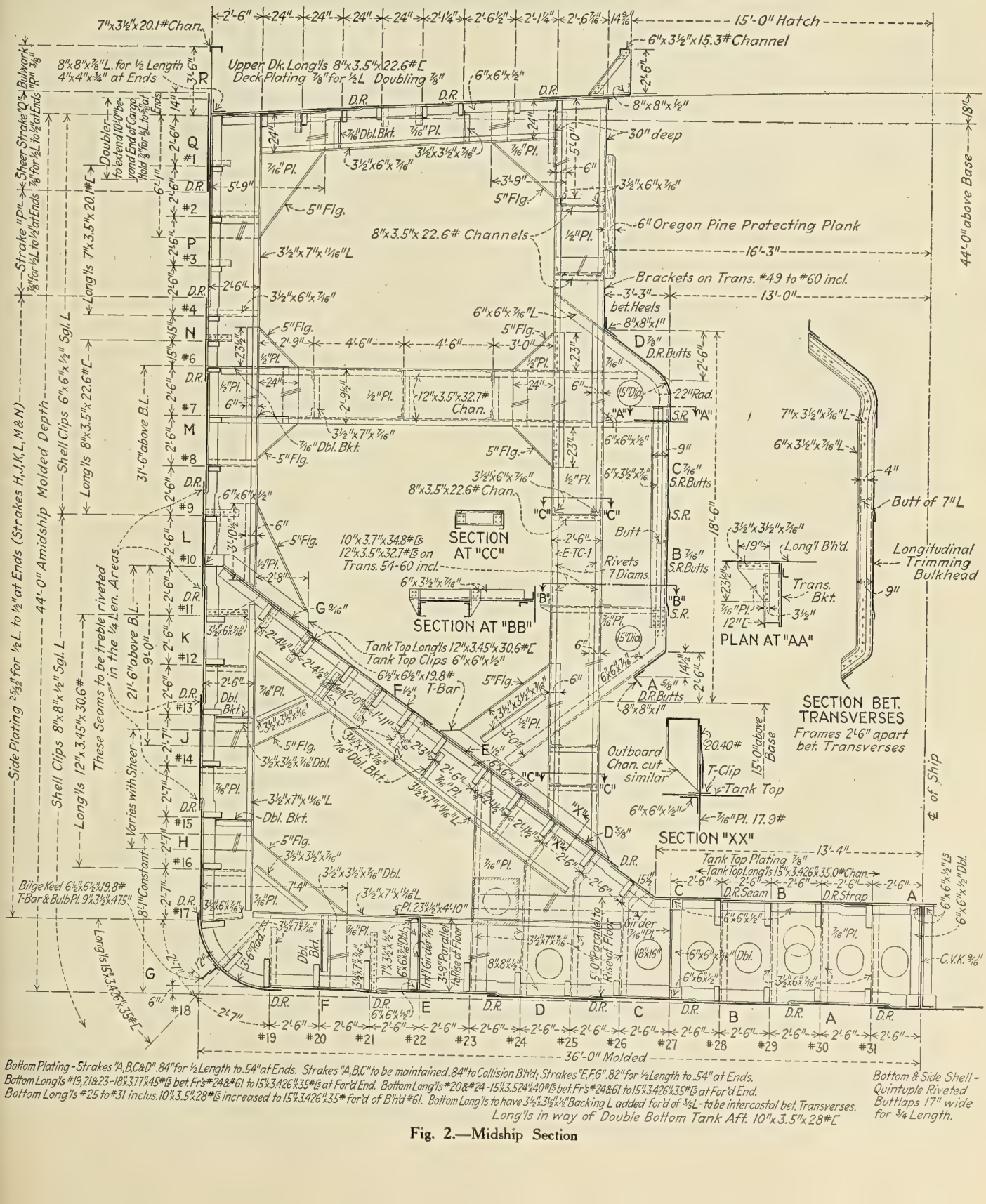

15'-0" Hatch
6"x3½"x15.3# Channel
44'-0" above Base
30" deep
8"x3.5"x22.6# Channels
6" Oregon Pine Protecting Plank
16'-3"
13'-0"
Brackets on Trans. #49 to #60 incl.
SECTION AT "CC"
SECTION AT "BB"
PLAN AT "AA"
SECTION BET. TRANSVERSES
Frames 2'-6" apart
SECTION "XX"
Tank Top Plating ⅞"
Tank Top Long'ls 15"x3.426x35.0#
Longitudinal Trimming Bulkhead
Butt of 7"L
Outboard Chan. cut similar
T-Clip
Tank Top
Bilge Keel 6½"x6½"x19.8#
Bottom Plating - Strakes "A,B,C&D" .84" for ½ Length to .54" at Ends. Strakes "A,B,C" to be maintained .84" to Collision B'hd; Strakes "E,F,G" .82" for ½ Length to .54" at Ends.
Bottom Long'ls #19,21&23-18"x3.77"x45#lb bet. Fr's #24&#61 to 15"x3.426"x35#lb at For'd End. Bottom Long'ls #20&#24-15"x3.524"x40#lb bet Fr's #24&61 to 15"x3.426"x35#lb at For'd End.
Bottom Long'ls #25 to #31 inclus. 10"x3.5"x28#lb increased to 15"x3.426"x35# for'd of B'hd #61. Bottom Long'ls to have 3½"x3½"x½" Backing L added for'd of ⅜L - to be intercostal bet. Transverses.
Long'ls in way of Double Bottom Tank Aft. 10"x3.5"x28#
Bottom & Side Shell - Quintuple Riveted Buttlaps 17" wide for ¾ Length.

Fig. 2.—Midship Section

Ore and Coal Carriers Chilore and Lebore

General Information

Service: Iron Ore and Coal, Sparrows Point, Maryland, to Cruz Grande, Chile.

Builder: Union Plant, Bethlehem Shipbuilding Corporation, Ltd.

Owner: Ore Steamship Corporation, New York City.

Characteristics

Length, overall	571'-6"
Length between perpendiculars	550'-1"
Breadth, molded	72'-0"
Depth, molded	44'-0"
Draft, loaded, designed	32'-4"
Draft, light, estimated	10'-9"
Block coefficient	0.815
Midship section coefficient	0.989
Longitudinal coefficient	0.826
Speed, loaded, knots	11.5
Cruising radius at 10.5 knots, nautical miles	20,000
Framing	Longitudinal
Class	A-1 American Bureau of Shipping

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull	7,950
**Weight of Propelling Machinery	950
Deadweight Capacity	20,700
Displacement	29,600

(In tons of 100 cubic feet)

Gross register	
Net register	

*Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

**Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

2 Bower Anchors, each	14,105 lbs.
1 Bower Anchor, spare	12,005 lbs.
1 Stream Anchor	5,040 lbs.
1 Kedge Anchor	2,135 lbs.
Chain Cable, 330 Fms.	2⅞" dia.
Stream chain, 105 Fms.	5½" cir. steel wire
Towline, 140 Fms.	7" cir. steel wire
Hawsers (3), 90 Fms.	8½" cir. manila
Warps (3), 90 Fms.	7½" cir. manila

Rudder

Area	244 sq. ft.
Dia. Stock	15"
C. Press. abaft C. L. pintles	4'-8"

Complement

Deck officers	5
Deck crew	19
Engineer officers	7
Engineer crew	12
Purser's and steward's department	10
Total officers and crew	53

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		129'-0" above deck
Derrick posts	10	Tubular	3 Ton	32'-0" high
Booms	18	Pine	3 Ton	36'-0"

Deck Machinery

Steering Gear....Screw gear type, 16"x12"
Windlass..(1) Triple spur geared, 13"x13"
Capstans
Winches, cargo, (10) 8¼"x10" compound geared (1) 9" x 12"
Winches, mooring, compound geared, (6) 10"x12"

Life Saving Equipment

	No.	Type	Length
Lifeboats	4		26'-0"
Workboat	1		16'-0"
Liferaft	1	25 persons	

Propelling Machinery

Boilers

Number	3
Type	Scotch, single ended
Length	12'-0"
Diameter	17'-6"
Furnaces, per boiler	4
Fuel	oil
Draft	Forced
Total heating surface, square feet	12,861
Total furnace volume, cu. ft.	2,226
Superheat, degrees F	200
Working pressure, lbs. per sq. in.	220
Normal fuel consumption:	
Per day, tons	43
Per horsepower hour, pounds	0.9
Normal steam production:	
Per hour per pound of fuel	15 lbs.
Total per hour	54,000 lbs.

Engines

Number	2
Type, Bethlehem-Curtis turbines, Falk single reduction gear	
Horsepower, normal	4,500
Horsepower, maximum	5,000

Propellers

Number	2
Type	Solid, three bladed
Weight, each, lbs.	16,000
Diameter	15'-8"
Pitch	12'-8"
R. P. M.	105
Projected area, square feet	56.85
Developed area, square feet	65.65

Auxiliary Machinery

Machinery Space

Condensers, main, 2....4,000 sq. ft.
Evaporators....(2) 30 tons each
Condensers, auxiliary, 1....1,000 sq. ft.
F. O. Starter heater
F. O. Meter
Feed water heater (1)....Multiflow
Fuel oil heaters (3)
1 Grease extractor.
4 Lubricating oil coolers.
1 Forced draft blower, 20" fan, 2-8"x16" vertical engines.
Pumps:
2 Main circulating, 14" centrifugal, 9 x 8 reciprocating engine.
2 Main air, 9½ x 17 x 15 independent dual with augmentor jets.
1 Combined auxiliary air and circulating 12 x 14 x 14 x 12.
1 Pair main feed, 15½ x 11½ x 24 vert. simp.
4 Forced lubricating oil, 7 x 8 x18 vert. simp.
1 Fire and general service, 10½ x 8 x 22 vert. simp.
1 Engine room bilge 7 x 8 x 18 vert. simp.
1 Sanitary, 1 bilge attached, each 6½ x 7½ inclined simp.
1 Fresh water, 4½ x 5 x 12 vert. simp.
1 Sanitary, 4½ x 5 x 12 vert. simp.
2 Water circulating for lubricating oil cooler, 9 x 10 x 21 vert. simp.
1 F. O. transfer, 7 x 8 x 18 vert. simp.
2 F. O. service, 7¼ x 5 x 10 horiz. simp.
1 Ballast, turbo-centrif., 100 h. p. turbine.
2 Bilge and ballast, 10 x 14 x 16 duplex.
1 Donkey boiler feed, 5 x 3½ x 6 vert. simp.
1 Donkey boiler, Scotch, 1 furnace, 317 sq. ft. H. S.

Refrigerating Machinery

2 2-ton ammonia direct expansion machines.

Electric Equipment

Generators 2....20 k. w., each driven by 9" x 7" vertical reciprocating engine.

Holds

No.	Length	Hatches (No.)
1	78'-0"	2
2	50'-0"	1
3	80'-0"	2
4	80'-0"	2
5	70'-0"	2

Capacities

Cargo Space

Compartment	Cu. Ft.
Hold No. 1	208,535
Hold No. 2	121,654
Hold No. 3	202,226
Hold No. 4	200,960
Hold No. 5	178,481
Total	911,856

Store Rooms

Compartment	Grain Cu. Ft.	Bales Cu. Ft.
Lower 'tween decks 61-4	23,228	22,222
Upper " " 61-4	16,477	15,547
" " " 64-stem	9,166	8,463
Lower " " P. 17-23	5,694	5,102
" " " S. 15-23	7,135	6,382
Total	61,700	57,716

Refrigerated Space

Compartment	Cu. Ft.
Meat room	1,418
Vegetable Room	1,245

Bunkers

Compartment	Gallons	Tons
No. 1 side tank, 57-61	141,282	497
No. 5 " " 29-32	132,854	467
No. 5 " " 25-29	165,532	582
Fuel tank 24-25	223,053	785
" " 23-24	114,234	402
Deep tank 61-64	226,734	798
Total	1,003,680	3,531

Tanks

Compartment	Tons F. W.	Tons S. W.
Engine room D. B.	50	
Boiler room D. B.	198	
On main deck aft	37	
Aft Peak	313	
Fore Peak		662
No. 1 tank P. & S. 53-61		920
No. 2 " " 48-53		998
No. 3 " " 40-48		1,601
No. 4 " " 32-40		1,601
No. 5 " D. B. 23-32		319
Aft Peak		322
Deep tank 61-64		866
No. 1 side tank 57-61		540
No. 5 " " 29-32		407
No. 5 " " 25-29		632
Total	598	8,968

necessary to evolve a design which would not only provide for a full deadweight cargo of either ore or coal, due consideration being given to the proper stowage of such a large tonnage of ore in an ocean-going steamer, but would permit of the quickest possible turn-a-round. To accomplish this it was of prime importance that all of the ore and coal be loaded and discharged through the same hatches, that while loading both kinds of cargo be self trimming, that during discharge the cargo carried in the wings would automatically trim to the center under the hatches and that the dense ore cargo would not only be distributed over the greatest possible length of the vessel to reduce the sagging stresses but so stowed that its center of gravity would be as high as possible to minimize the rolling stresses.

Arrangement of Cargo Holds

Reference to the midship section and diagrams (Figs. 1 and 2) will perhaps convey a clearer idea than a lengthy description of how these various features were combined to produce what it is believed will prove an ideal combination ore and coal steamer. It will be noted that there are two fore and aft trimming bulkheads spaced so that there is a central ore hold 26 feet wide. The trimming bulkheads extend the full length of the cargo holds so that the ore can both be distributed over the greatest possible length and also be so confined transversely that its center of gravity will be at a suitable height. Attention is also called to the deep continuous openings at both the top and bottom of the trimming bulkheads. These openings, in connection with the sloping wing tanks at the bottom, not only allow the coal cargo during loading to flow freely over the top into the wings but also to trim to the center during the operation of discharging.

Features of Design

The trimming bulkheads are very substantially constructed and supported. In fact they are sufficiently strong to support the full weight of ore cargo on a 90-degree angle of heel, which it is needless to say could not be experienced.

The cargo holds are subdivided into five compartments by watertight transverse bulkheads.

The question of repairs incident to carrying ore improperly stowed both on the Great Lakes and on ocean voyages was given much thought in the design of both the ore-oil steamers and the ore-coal steamers. Many vessels carrying rails, pig iron and similar cargoes have met with serious damage on account of a reasonable proportion of the heavy cargo not being distributed in the 'tween decks. Many ingenious methods were resorted to, in the early wooden vessels carrying Spanish copper and iron ore, to raise the center of gravity of the cargo. This was accomplished sometimes by carrying empty barrels in the wings. In other cases the center of gravity was raised by fitting a false deck of wood very heavily shored and this was often made more effective by fitting two fore and aft bulkheads of wood spaced about a half breadth from the center on each side and substantially braced. It was found that vessels carrying ore in this manner were subject to no greater stresses or required no more repairs than when carrying general cargoes in the ordinary way.

The six large combination ore carriers are designed on correct principles in this respect and it is confidently believed that the carriage of iron ore stowed as it is in these vessels will create no greater stresses on the vessels as a whole or locally on any of the members than experienced with general cargoes properly stowed. The wear and tear due to loading and discharging the ore has been provided for by exceptionally heavy plating and framing forming the floor of the holds as compared with lake ore carriers. Notwithstanding the elimination of all the traditional objections connected with the ore carrying trade and a strict compliance with the laws of nature, the stresses affecting the vessels as a whole and every member locally have received a most thorough and exhaustive study. With a view to taking no chances and securing every possible insurance against these vessels being laid up for repairs, an excessive amount of steel has been introduced into their construction.

Ratio of Deadweight to Steel

The deadweight in tons divided by the steel in tons on the ore-oil steamers ranges from 2.78 to 2.88 and on the ore-coal steamers is 2.95. It is common for tankers to carry from 3.25 tons deadweight and up per ton of steel and freighters often carry from 3.4 tons and in some cases as high as 4.3 tons deadweight per ton of steel. When it is considered that there is little control over the stowage in ordinary vessels and that the stowage, especially of the iron ore, is absolutely and automatically controlled in the combination ore steamers, the advantages of the design become obvious.

The following table, giving some particulars of a number of vessels and the deadweight carried per ton of steel, should prove of interest in connection with the relatively large tonnage of steel used in the construction of these excptionally strong vessels.

If all the above vessels with the exception of the Lake ore steamer were reduced to a common block coefficient, the relative quantity of steel in the Bethlehem ore steamers would appear greater. The difference in deadweight to steel between the *Bethore* and the *Steelore* is due to the elimination of some steel which the builders objected to in the first two vessels and does not in any way detract from the strength.

The old *Bethore*, which is a vessel of exactly the same type as the present ore-oil steamers except that one additional deck is fitted, shows a much higher efficiency so far as steel to deadweight is concerned. The plans for this vessel were approved by one of the classification societies and it was considered an exceptionally strong vessel; at the same time there

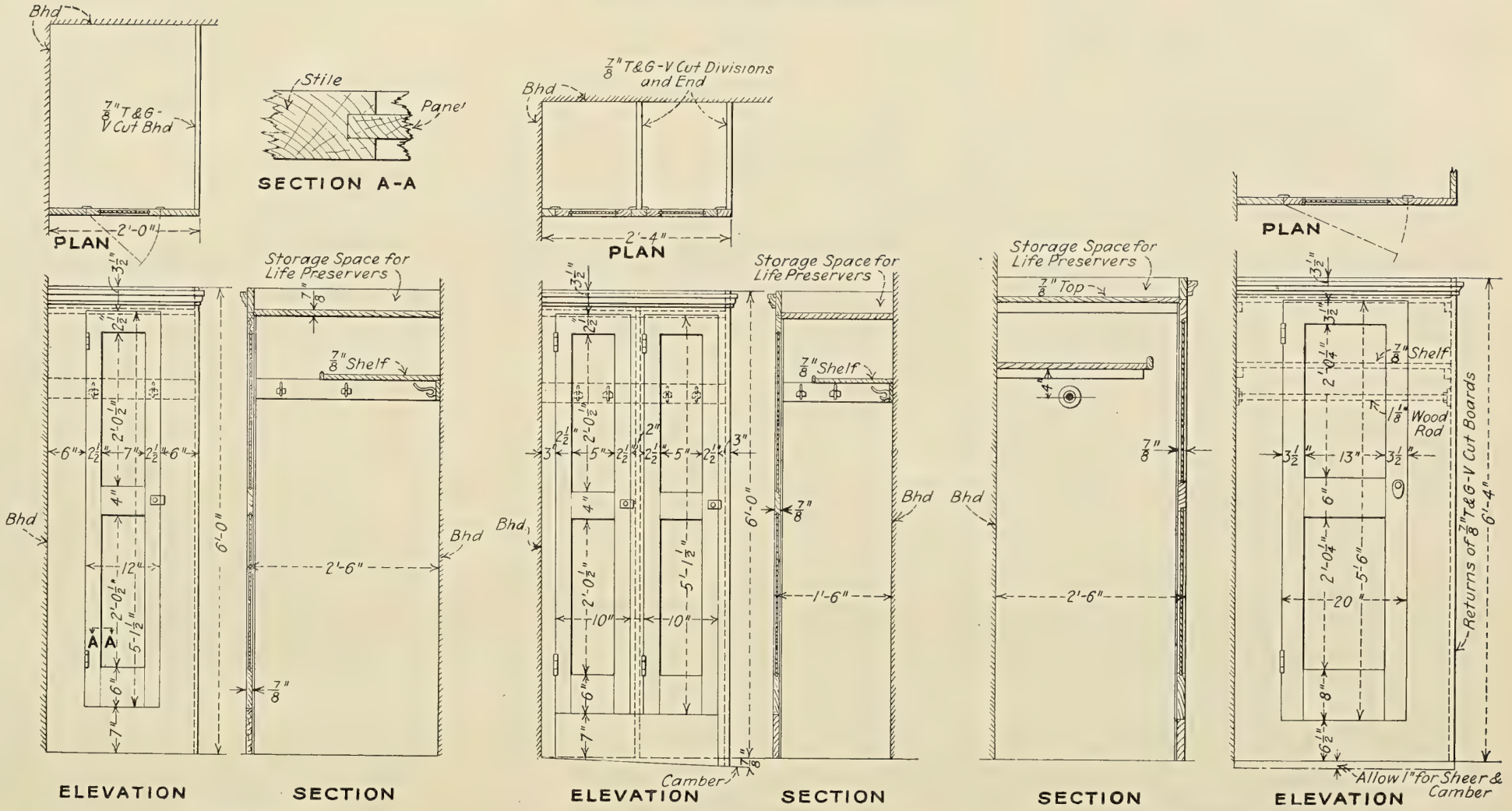
(*Concluded on page* 413.)

Table Showing Deadweight Carried Per Ton of Steel for Various Vessels

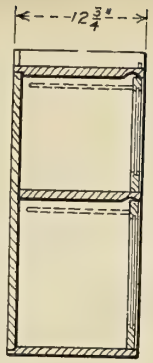
	New *Bethore* Ore and Oil Steamer	*Steelore* Ore and Oil Steamer	*Chilore* Ore and Coal Steamer	Old *Bethore* Ore and Oil Type	*Cubore* Ore and Coal Steamer	Lake Ore Steamer	Newport News 20,300 Deadweight Tanker	*San Fernando* Tanker	*F. W. Woller* Tanker	*War Knight* Freighter	*Eclipse* Freighter
Length	550	550	550	500	450	580	550	530	500	410	440
Breadth	72	72	72	66	57	58	75	69	68′-6″	56	56
Depth, Molded	44	44	44	42	37	32	43′-3″	42′-3″	38	41	38
Draft	32′-4″	32′-4″	32′-4″	31′-1″	27′-3″	19′-3″	30′-0″	30′-8¼″	27′-3″	30′-6″	28′-7¾″
Block Coefficient	.815	.815	.815	.8065	.795	.868	.80	.805	.80	.799	.797
Displacement	29,600	29,600	29,600	23,723	15,865	16,060	28,270	25,800	21,275	15,925	16,000
Steel	7,300	7,100	7,000	5,200	3,273	3,929	6,025	5,666	4,663	3,082	2,800
Deadweight DW	20,320	20,500	20,700	17,200	11,669	11,451	20,300	18,550	15,000	11,823	12,000
Steel	2.78	2.88	2.95	3.3	3.56	2.91	3.36	3.27	3.21	3.83	4.3

Ship Joiner Plans

LOCKERS, WARDROBES AND BOOK CASES



Details of Construction of Lockers and Wardrobe



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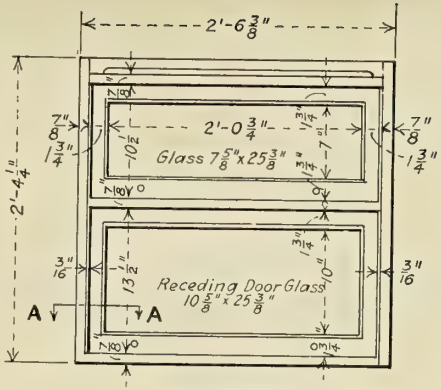
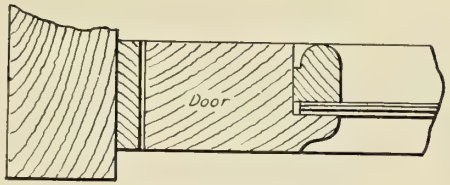


ELEVATION



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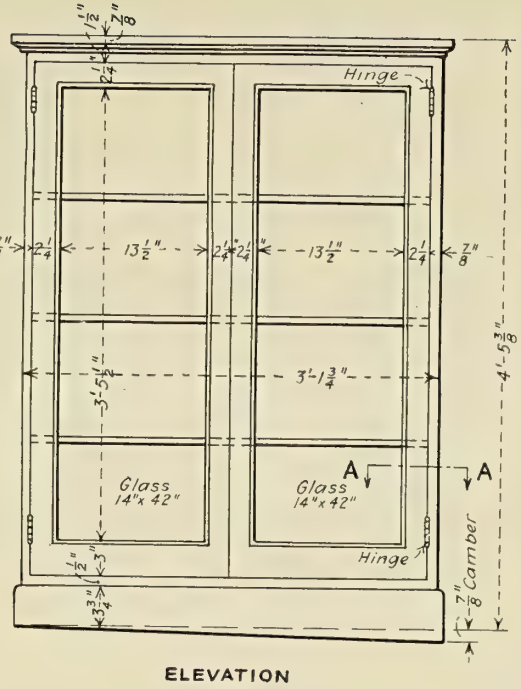
BOOK CASE ON ROLL TOP DESK



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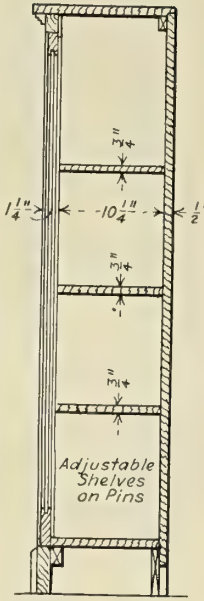

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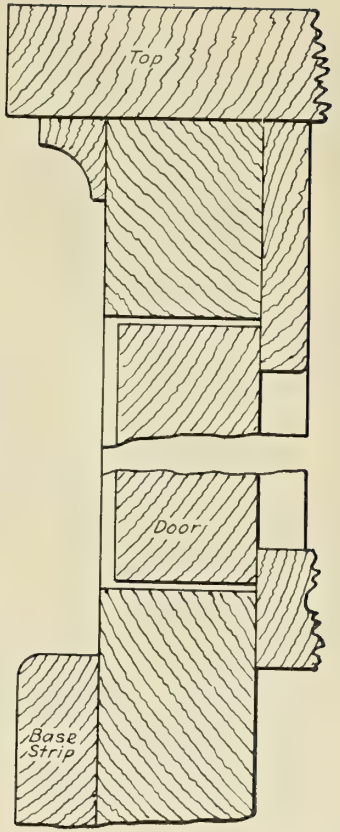
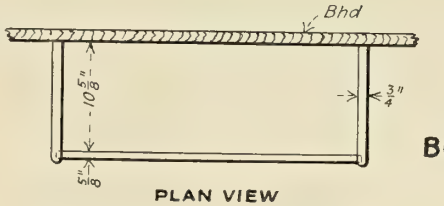
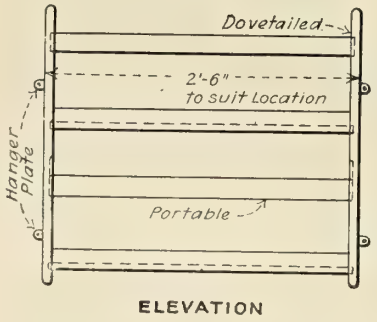


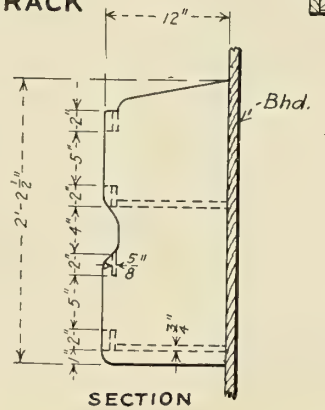


PLAN VIEW

BOOK RACK



ELEVATION



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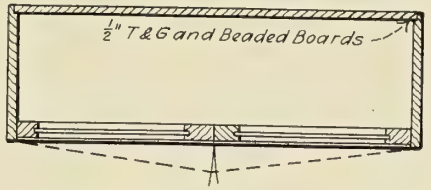
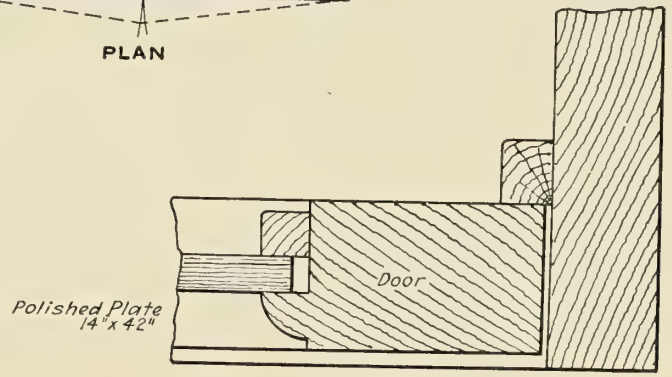


PLAN

FLOOR BOOK CASE



SECTION "A-A"

Details of Construction of Book Rack and Book Cases

Steel and Iron for Shipbuilding Purposes

By Horace Holden Thayer*

This is one of a series of articles containing information regarding shipbuilding materials and their uses that is not readily obtainable from shipbuilding handbooks and other generally available sources. The articles are not intended to be a complete exposition of the subject but will be found to contain items of value to the various classes of workers who have to deal with these materials from the materials point of view.

STEEL and iron are the most important materials entering into the construction of commercial vessels of all classes—steel, composite, wood or concrete. Therefore they merit first consideration among such materials. Although not generally so recognized, a wood steamship is essentially a steel industry proposition; and the cost of the iron or steel fastenings in a wood ship alone constitutes a large percentage of the cost of the hull materials.

Physical Properties

The physical properties of the steel or iron, whether for ship, boiler or machinery use, are specified in classification society rules, and where the vessel is classed they are fully taken care of by these rules and the inspection and tests that are made in conformity with them. So they need not be dwelt upon here. Even where a vessel is not classed, it is by all means advisable to adopt classification society standards or some other good standards for the items that, on classed vessels, have to be up to certain specified requirements. The properties of boiler steel and iron are specified by the Rules and Regulations of the United States Steamboat Inspection Service for all vessels under their jurisdiction.

Chemical Properties

The chemical compositions of steel and iron for structural parts of the hull or machinery, for shafting, connecting rods and other highly stressed parts, for springs, for screw stock, for alloy steel and tool steel of different grades, for cast steel, for the general run of iron castings and for cylinder castings, are furnished by the engineering handbooks, which also give information regarding heat treatments where such are necessary. Large manufacturers of machinery also have their standards for the chemical compositions and heat treatments of the materials that they have to work up into the finished product.

Requirements

During the war the classification societies waived their individual requirements to the extent of accepting ship steel that would conform to specifications A-12-16 of the American Society for Testing Materials. As it may be considered desirable to adopt these specifications where strict adherence to classification requirements is not necessary, and as they may not be familiar to the readers of this paper, their principal features are here given:

Tensile strength = 58,000 to 68,000 pounds per square inch.

Minimum yield point, determined by the drop of the beam of the testing machine = ½ of tensile strength.

$$\text{Minimum elongation in 8 inch, percent} = \frac{1{,}500{,}000}{\text{tensile strength.}}$$

For material over three-quarter inch thick a deduction of 1 percent from the percent given by the above formula is made for each increase of one-eighth inch in thickness above three-quarter inch, with 18 percent as the minimum. For material one-quarter inch thick or less the elongation is to be measured on a gage length of 24 times the thickness of the specimen.

The bend test specimen is to bend cold through 180 degrees without cracking on the outside of the bent portion. Material three-quarter inch thick or less is to be bent around a pin of the same diameter as the thickness of the specimen; material over three-quarter inch up to and including one and one-quarter inch thick is to be bent around a pin of a diameter 1½ times the thickness of the specimen; and material over one and one-quarter inch thick is to be bent around a pin whose diameter is twice the thickness of the specimen. Other test requirements of these specifications are in general those adopted by classification societies and others to assure the obtaining of representative specimens and fair tests.

It will be noted that the tensile test limits are almost identical with those adopted by the principal classification societies for steel that is to be flanged when cold; and that for the general run of plates and sections the low and high limits are about 4,000 pounds lower than the classification society limits. It will also be noted that the method of specifying the minimum elongation is a departure from classification society practice.

Steel Not Subject to Test

The advisability has been referred to of specifying standard properties for such items of steel or iron in unclassed vessels as would be governed by classification requirements, if the vessel were classed. There are, however, in all vessels many items where questions of structural strength or other special features are not involved and which even on classed vessels do not have to be up to the standards of items that have these special requirements to meet.

The steel companies refer to any steel that is not tested and may have any tensile strength from very high to very low as tank steel. It is their basis steel and sold at the base price. If structural steel is ordered without special test requirements it will genrally have a tensile strength ranging from 55,000 to 68,000 pounds per square inch, though there is no guarantee as to this. With orders for this steel, however, the steel companies will usually, if desired, furnish free of charge a record of their own mill test of the material. The price is the same as for the tank steel. Where steel is ordered to meet classification society inspection and test requirements, the price is still the same, except for special grades, and the only extra charge is that made by the classification society.

A very considerable percentage of steel hull material on a classed vessel can be ordered of untested steel, at a corresponding saving in the fees for test and inspection of the material, and also a saving in time. Some of the items in the testing of which the classification societies are not interested, unless the construction is something out of the ordinary, are listed below. For such items it is recommended that structural steel be specified rather than tank steel and that the mill test of the material be requested.

Plates

Screen bulkheads.
Chain locker when not part of main bulkhead.
Dynamo flats, etc.
Engineer's store room and similar enclosures.

* Member of Rossell & Thayer, Naval Architects and Marine Engineers, Philadelphia, Pa.

Coal chutes.
Trunks to store rooms.
Bilge keels.
Bulkhead and watertight floor shell liners.
Miscellaneous liners.
Uptakes and support brackets.
Miscellaneous bulkheads and partitions above the upper deck.
Cargo mast or derrick platforms or tables.
Bow chocks.
Hatches on poop, bridge and forecastle and superstructure decks.
Houses on poop, bridge and forecastle and superstructure decks.
Coaling hatches on casings.
Fidley top.
Engine, boiler and galley skylights.
Ventilators, except coamings.
Stack.
Independent fresh water tanks.
Gravity tanks.
Checkered plates for engine and boiler room floors.

Shapes

Screen bulkhead stiffeners.
Chain locker when not part of main bulkhead.
Dynamo flats, etc.
Engineer's store room and similar enclosures.
Coal chutes.
Trunks to store rooms.
Hawse and chain pipe collars.
Tank top manhole stiffening rings.
Bilge keels.
Uptake angles and supports.
Miscellaneous bulkheads and partitions above the upper deck.
Cargo mast or derrick platforms or tables.
Mast hull angles and deck rings.
Bulwark rail and braces.
Batten bars for hatches.
Hatches on poop, bridge and forecastle and superstructure decks.
Houses on poop, bridge and forecastle and superstructure decks.
Bow chocks.
Coaling hatches on casings.
Fidley top.
Engine, boiler and galley skylights.
Ventilators.
Stack.
Independent fresh water tanks.
Gravity tanks.

Half rounds, half ovals, and flat bars for moldings, liners, fenders, etc., are not subject to classification inspection and test.

Other Hull Plate Considerations

When dealing with hull plates from the standpoint of materials, the following considerations present themselves as being of importance.

Plates have to be laid off in such lengths and widths as can be readily obtained from the rolling mills. The maximum length that can be rolled by a majority of the smaller mills runs from 30 feet for plates ⅜ inch by 60 inches to 16 feet for plates ¾ inch by 72 inches; although a few of the larger mills can greatly exceed these figures. Care has also to be taken that plates which require rolling are not ordered too long to go into the rolls and that furnaced plates are not ordered too large to go into the furnace.

Steel companies having universal mills can furnish plates of any length within width limits of about eight inches to forty-eight inches and limits of thickness of about one-quarter inch to two inches. They are accepted by the classification societies subject to the usual test requirements. These plates, however, have rounded edges and, if required for use where one or both edges have to be calked, they have to be ordered sufficiently wide to allow of planing or chipping off this rounded edge. Universal mill plates are furnished at the base price.

The classification societies either place a minimum limit on the length of a shell plate of a certain width or require special strength in the riveting of the butts.

Joggling of shell plates or deck plates to eliminate the liners that would otherwise be required in way of the outer strakes results in rapid corrosion of the plate along the joggle, and is therefore not a good practice. Furthermore, many repair yards do not have facilities for proper renewal of joggled plates.

On account of the extras charged by steel companies for sketch plates it is in many cases desirable to order rectangular plates, to be cut to shape later at the shipyard. This is particularly true of beam knees and brackets generally, which can be laid off in pairs on rectangular plates in a manner to have very little waste of material.

A convenient and accurate method of making up a schedule of shell plating is to have the plating completely laid off on a wood model and a scale of from one-fourth inch to one-half inch to the foot, according to the size of the vessel, to trace off the plates in strakes on strips of tracing paper; and to measure the plates from these strips.

Other Hull Shape Considerations

When dealing with hull shapes from the standpoint of materials, the following considerations present themselves as being of importance:

Bulb angles are more economical of material than plain angles.

Where channel framing can be six inches or smaller, bulb angles should be substituted in tanks, double bottoms or other compartments designed to carry oil, because the inner flange of the channel interferes with the proper holding on of the rivet.

Structural channels except in sizes fifteen inches or larger are not satisfactory for ship use generally on account of the narrow flange width and the great slope of the inner face of the flange.

Plates should be substituted for angles that require to be shaped to a very open bevel, as the bevel cannot be worked right to the heel of the angle.

The number of different shapes and sizes should be reduced to a minimum. This will result in a saving of time in changing rolls at the mill, work toward a reduction in the amount and variety of stock material to be kept on hand at the shipyard and lessen the liability of items having to await the accumulation at the mill of other orders for a sufficient amount of similar sizes to warrant a rolling. This subject was considered of such importance during the recent war that an examination was made of the shape material schedules of over 1,500 vessels building for the United States Shipping Board, having a deadweight carrying capacity of 10,302,150 tons and requiring 1,100,651 short tons of steel shapes. It was found that over 400 different sizes and weights of shapes were specified, even assuming thicknesses of the same size of any shape not differing more than 2½ percent as being the same. It was also found that many weights were specified in lots of less than 100 pounds per hull. In one design that was produced at several shipyards the number of different sizes and weights of shapes adopted by the builders ranged from 45 to 73; in another design also produced at several shipyards, from 29 to 45. The yards using the greater number of sizes and weights do not appear to have made any gain in deadweight or effected any appreciable saving in steel thereby. In fact in one of the above mentioned designs, investigated by the writer, where the propelling machinery and other important factors are identical, the light ship in which 45 different sizes and weights of shapes were used displaced 40 tons more than the light ship whose builder used 29 different sizes and weights. An analysis of twelve representative schedules made by the technical department of the Emergency Fleet Corporation indicated that by concentrating on a proposed standard list of shapes which comprised 107 different sizes and weights, and without serious change in existing details or templates, the average number of sizes and weights of shapes per hull could be reduced to about 75 percent of their variety as scheduled, with an increase in the average weight of steel of less than one ton per hull. The list of ship channels, except a popular 6-inch by 3½-inch by

15-pound size, and the list of bulb angles, were based on British standards, which are more economical of material and therefore more desirable than have been generally produced by our rolling mills in the past.

In the latter part of 1918 this proposed standard list was submitted to the representative steel shipyards and rolling mills with request for comment and criticism; and as a result a somewhat modified list, shown in Table 1, was adopted as a standard. Furthermore the steel makers agreed to alter their ship channel and bulk angle rolls at as early a date as possible to enable them to roll these sections in conformity with the British standards.

It will be noted that there are 112 different sizes and weights in this standard list; and it is a very good one to use as a basis, making the minimum number of departures from it necessary to meet design requirements and rolling mill facilities. The T-bar was included in the standard list on account of its use for bilge keels and bulkhead bounding bars, and the Z-bar was included on account of its convenience as a rabbet for hatch covers.

TABLE 1

EQUAL LEG ANGLES

Size	Thickness Inches	Wt. per Ft. Lbs.	Size	Thickness Inches	Wt. per Ft. Lbs.
6 x 6	.75	28.7	3½x3½	.625	13.6
	.6875	26.5		.5625	12.4
	.625	24.2		.50	11.1
	.5625	21.9		.4375	9.8
	.50	19.6		.375	8.5
	.4375	17.2		.3125	7.2
	.375	14.9			
			3 x 3	.50	9.4
5 x 5	.625	20.0		.4375	8.3
	.5625	18.1		.375	7.2
	.50	16.2		.3125	6.1
	.4375	14.3		.25	4.9
	.375	12.3			
			2½x2½	.3125	5.0
				.25	4.1
			1¾x1¾	.1875	2.12

UNEQUAL LEG ANGLES

6 x 3½	.75	22.4	5 x 3	.6875	17.1
	.6875	20.6		.625	15.7
	.625	18.9		.5625	14.3
	.5625	17.1		.50	12.8
	.50	15.3		.4375	11.3
	.4375	13.5		.375	9.8
	.375	11.7		.3125	8.2

BULB ANGLES

Size	Thickness of Longer Leg, Inches	Wt. per Ft. Lbs.	Size	Thickness of Longer Leg, Inches	Wt. per Ft. Lbs.
10 x 3½	.675	33.2	7 x 3½	.525	19.9
	.625	31.1		.475	18.3
	.575	29.1		.425	16.8
	.525	26.9		.40	16.1
	.50	25.9			
			7 x 3	.45	16.7
9 x 3½	.625	28.3		.40	15.3
	.575	26.4		.375	14.6
	.525	24.5			
	.475	22.7	6 x 3	.475	15.5
	.45	21.8		.425	14.1
				.375	12.8
				.35	12.2
8 x 3½	.55	23.1			
	.50	21.3			
	.45	19.6			
	.425	18.8			

SHIP CHANNELS

Size	Web Thickness Inches	Wt. per Ft. Lbs.	Size	Web Thickness Inches	Wt. per Ft. Lbs.
12 x 4	.825	48.8	9 x 3½	.65	31.5
	.725	44.7		.55	28.5
	.625	40.6		.45	25.4
	.525	36.5		.40	23.9
	.475	34.5			
			8 x 3½	.525	25.4
12 x 3½	.70	41.1		.475	24.1
	.60	37.0		.425	22.7
	.50	32.9		.375	21.3
	.45	30.9			
			7 x 3½	.40	20.2
10 x 3½	.575	31.6		.35	19.0
	.475	28.2		.30	17.8
	.425	26.5			
	.375	24.8			
			6 x 3½	.35	15.0

TABLE 1—*Continued.*

STRUCTURAL CHANNELS Size	Web Thickness Inches	Wt. per Ft. Lbs.	I BEAMS Size	Web Thickness Inches	Wt. per Ft. Lbs.
15 x 3½	.818	55.0	24 x 7	.50	80.0
	.72	50.0	20 x 7	.60	80.0
	.622	45.0	6¼	.50	65.0
	.524	40.0	18 x 6	.555	60.0
	.426	35.0		.46	55.0
	.40	33.0	15 x 5½	.41	42.0
			12 x 5½	.46	40.0
	TEES		10 x 4¾	.31	25.0
6½ x 6½	.45	19.8	8 x 4	.27	18.0
			HATCH ZEE (Tyzack)		
			2½	.50	13.6

ORDER OF SHIPMENT OF HULL MATERIAL

There is sometimes considerable difficulty in obtaining first from the mills the material on any order that is desired first; and shell or keelson plates are found to be not available when needed, while hatch and skylight material has been delivered in abundance. In fact there have been occasions when the keel plates were among the last to reach the shipyard. This situation can be avoided by ordering for first shipment those items that are needed first; and the following schedule will be found to be a good general guide for such ordering:

First Shipment

Keel plates and shapes.
Centerline keelson plates and shapes.
Side keelson plates and shapes.
Margin plates and angles.
Tank top plates and shapes.
Floor plates and shapes.
Bottom shell plates.
Bottom shell liners.
Stem and stern frame.

Second Shipment

Bilge floor plates and angles.
Bilge gusset plates.
All frames and brackets.
Web frame plates and shapes.
All hold bulkhead plates and shapes.
Shaft tunnel plates and shapes.
Hold stringer plates and shapes.
Hold pillar plates, shapes and bars.
Hold girder plates and shapes.
Watertight flat plates, angles and beams.
Second deck beams and brackets.
Second deck plates and angles.
Panting beams and brackets.
Machinery foundations, etc.
Remainder of shell plating and bulwark, and liners and moldings.
Bilge keel plates, shapes and bars.
Rudder plates and shapes.

Third Shipment

Between deck pillars, plates, shapes and bars.
Between deck girders, plates and shapes.
Upper deck beams and angles and brackets.
Upper deck plates and angles.
Bridge, forecastle and poop deck beams and brackets.
Bridge, forecastle and poop deck plates and angles.
All casings and houses, plates and shapes.
Mast, boom and king post, plates and shapes.
Fresh water tank plates and angles.

Boat skid beams and brackets.
Hatch coamings and webs, plates and brackets, shapes and bars.
Skylight and companion plates and angles.
Winch platform, plates and shapes.
Bridge plates and shapes.
Checker plates, etc.

The Amount of Hull Steel in a Steel Vessel

The determination of the amount of steel plates, shapes, bars and rivets in a steel vessel is important from a materials' standpoint as well as from other standpoints, and many formulæ have been devised for arriving at it. For vessels of the same type with little variation in detail features of the design, formulæ with coefficients based upon the weight of steel in one of the vessels will give a close approximation to the weight of steel in the similar vessels; and the simpler the formula the better. The attempt to produce a formula that will apply to dissimilar vessels results in greater complication of the formula and the amounts of steel determined by it must of necessity, outside of a narrow range, be only approximations to the actual amount. The approximation approaches the actual in proportion as the vessel dealt with approaches in similarity the vessel from which the coefficient used in the formula was derived. This can be readily seen by a study of Table 2, which includes only a few of the many types of vessels.

$$\text{Wt.} = \text{Coeff.} \times \frac{L \times B \times D}{100}$$

	Coefficient for Formula
13 oil tankers	.46 to .65
4 oil tank barges	.48 to .54
25 double bottom cargo steamers	.34 to .52
16 single bottom steamers	.31 to .44
28 steamboats	.24 to .49
7 steam yachts	.24 to .44
4 schooner yachts	.17 to .23
7 double ended ferryboats	.32 to .44
11 tugboats	.34 to .55
6 miscellaneous barges	.35 to .51

Column 7 shows an attempt to eliminate one factor of difference by using a corrected depth that makes allowance for variations in sheer and erections. In this formula

$$\text{Dc} = \text{D} + \frac{\text{Sum of bow and stern sheers}}{6} + \frac{\text{length of P. B. \& F. x ht. of P. B. \& F.*}}{\text{Length of vessel between perps.}}$$

* Length of Poop, Bridge and F'c's'tle by height of Poop, Bridge and F'c's'tle.

For vessels that are similar except for differences in the sheer and erections this formula is preferable to that of column 6, but nearly as much discretion has to be used in the selection of a coefficient as when using the more simple formula.

TABLE 2

No.	(1) Attained Deadweight With Scotch Boilers and Reciprocating Engines—Tons	(2) Type	(3) Framing	(4) Invoice Steel in Short Tons, Assuming 10% for Scrap	(5) Coefficient for Formula $Wt. = C \times D.W.$	(6) Coefficient for Formula $Wt. = C \times \frac{L \times B \times D}{100}$	(7) Coefficient for Formula $Wt. = C \times \frac{L \times B \times D_c}{100}$	(8) Coefficient for Formula $Wt. = C \times \frac{L \times B \times D_c}{100} \times \frac{1+b}{2}$	(9) Coefficient for Formula $Wt. = C \times \left(\frac{L(B+D)}{1{,}000}\right)^{1.3}$
1	9374	Shelter Dk. with Short Poop and F'c'stle.	Longt.	2840	.303	.386	.346	.389	13.6
2	9695	Shelter Dk. with P. B. & F.	Longt.	3020	.312	.398	.341	.383	14.2
3	8541	Three Island	Transverse	3340	.391	.507	.407	.452	16.6
4	3525	Three Island	Transverse	1360	.386	.516	.432	.479	19.5
5	10000	Tanker-Poop Short Bridge & F'c'stle.	Longt.	3920	.392	.480	.415	.461	16.1
6	7520	Tanker-Poop Short Bridge & F'c'stle.	Longt.	3140	.418	.520	.437	.489	17.6
7	....	Ocean Tug Steel House	Transverse	275	....	.425	.387	.545	17.6
8	....	Harbor Tug Steel House	Transverse	160	....	.552	.510	.718	24.6

The relation between the weight of steel and the deadweight of the vessel is shown in column 5 of Table 2. It is never anything more than an approximation; but for vessels of any particular type and service, it is a measure of the economy of their proportions from the materials standpoint.

The most generally used formula is that of column 6, figuring the weight of steel as proportional to the product of the length between perpendiculars, the breadth molded and the depth molded to the top complete deck. It will be noted that, while the coefficients, for vessels of a type are quite close together, the large tanker has a lower coefficient than the small dry cargo boat. An idea of the great range of coefficients when using this formula may be obtained from the following tabulation, which has been made up from a considerable number of actual material order schedules and detailed weight estimates. The coefficients are for the weight of invoice steel in tons of 2,000 pounds.

A still further refinement is shown in column 8 where an attempt is made to take care of the differences in the fullness of the vessels by introducing the factor

$$\frac{1 + \text{the block coefficient}}{2}.$$

The result is a formula which is still far from being of wide application without variation of the coefficient. However, if we compare the shelter deck longitudinally framed vessel No. 1 with the poop, bridge and f'c's'tle, transversely framed vessel No. 3 we find that whereas with the formula of column 6, the difference between the coefficients is about 31½ percent of the low value, with the formula of column 7

it is only 17½ percent, and with the formula of column 8 only 16 percent. A reasonably close approximation to the weight of steel in a cargo vessel of usual construction and proportions can be obtained by the use of this formula and a coefficient based upon actual weights of dry cargo vessels with transverse framing designed to meet the requirements of the American Bureau of Shipping as a group by themselves, similar vessels designed to meet the requirements of Lloyd's Register of Shipping as another group, longitudinally framed vessels as other groups, etc.

Column 9 illustrates the application of another formula that is sometimes used, the dimensions being those of the preceding formulæ.

Still another method of determining the weight of steel is to figure up from the midship section plan the weight per foot of length of vessel of all structural items below the weather deck that extend for at least one-half the vessel's length, including stanchions, bilge keels, moldings and fenders, and to multiply this by the length and by a coefficient. This coefficient for short tons of invoice steel will be in the neighborhood of 1.5, but like those listed in Table 2 varies considerably. The less the material used in the ends of the vessel and for purposes other than strength requirements, the lower will be this coefficient.

The amount of steel shown in Table 2 is taken for convenience as 110 percent of the net steel and any of the coefficients can be reduced to those for displacement tons of net steel by multiplying by the factor $\frac{2{,}000 \times 100}{2{,}240 \times 110}$.

Proportion of Plates, Shapes, Etc., in Total Invoice Hull Steel

Having estimated the amount of structural steel in a vessel it is of interest to know how much of it consists of plates, how much shapes, etc. This is best arrived at by settling upon the small percentage of bars, hull forgings, and rivets and dividing up the remainder between plates and shapes in the usual proportions, the shapes being angles, bulbs, channel and other sections of that nature. An assumption of 3 percent for flats, rounds and other bars, and hull forgings, and an assumption of 5 percent for rivets, will not be far out of the way. This leaves 92 percent for plates and shapes.

An examination of a considerable number of material order schedules and detailed estimates shows the following relationship of shapes to plates, when extreme cases which are manifestly out of the running are eliminated and an approximate mean value of the others is taken:

	Proportion of Shapes to Plates
Oil tankers	.50
Oil tank barges	.43
Double bottom cargo steamers	.44
Single bottom cargo steamers	.45
Steamboats	.45
Steam yachts	.47
Schooner yachts	.43
Double ended ferryboats	.50
Miscellaneous barges	.40

Using the above figure for a double-bottom freighter, we would have

	Percent
Plates $\frac{100}{144}$ of 92 percent, or	64
Shapes 64 × .44, or	28
Bars and forgings	3
Rivets	5
	100

which would mean for vessel No. 3 of Table 2.

Plates	2,135
Shapes	935
Bars and forgings	100
Rivets	170
	3,340

As before stated the figure here used is based on the assumption of 10 percent allowance for scrap. An allowance of 15 percent for scrap would run the plates up to about 2,250 tons.

As previously stated 10,302,150 deadweight tons of Shipping Board steamships were found to have 1,100,651 tons of shapes. From the above table and the relative proportion of dry cargo vessels to tankers we would expect the shapes to be about 45 percent of the plates. With the foregoing assumption of 92 percent of the total steel for plates and shapes the shapes would then be about 28½ percent of the total.

A mean value of the coefficient of column 5, Table 2, shows total steel of about 37 percent of the deadweight. On this basis the shapes would be 28½ percent of 37 percent, or 10½ percent of the deadweight. 10½ percent of 10,302,150 deadweight tons is about 1,082,000 tons, which differs less than 2 percent from the actual amount. As the above listed proportions of shapes to plates were not derived from any of the Shipping Board vessels, this rough check serves to illustrate their reliability within reasonable limits.

Weight of Steel or Iron Fastenings in a Wood Hull

Mention was made at the beginning of this paper of the importance of steel and iron in wood ship construction. The following table, showing the weight of metal fastenings in pounds per board foot of timber used up in the construction of the vessel, may be of value. The figures, cover bolts, spikes, tierods, and strapping.

2,500-ton deadweight schooner barge built before the war. Not classed but substantial construction. .33 pound per board foot.

2,500-ton deadweight schooner barge built during the war. Classed with the American Bureau of Shipping and fastenings equal to or in excess of their requirements. .42 pound per board foot.

4 types of wood steamships of from 3,500 to 4,000 tons deadweight classed with the American Bureau of Shipping. .3 to .4 pound per board foot.

Another type of steamship in which the strapping is replaced by double diagonal wood sheathing between the frames and the outside planking comes within the range above listed when some structural steel used as a sheer strake, deck stringer plate, etc., is included.

Corrosion of Steel and Iron

The corrosion of steel is much more rapid than that of iron. There are a number of iron vessels in service which were built from 40 to 50 years ago, the hulls of which are of the original material and in very good condition. There are also iron boilers of that age still in service and passed by the United States Steamboat Inspection Service, and their shells when drilled are found to be the original thickness. The building of iron vessels is, however, no longer a commercial proposition on account of the lack of rolling mills producing the material, and because of the fact that the inferiority of iron to steel in strength calls for greater weight to meet classification requirements and therefore a resultant decrease in the deadweight carrying capacity of the vessel. There are a few points, however, that it is well to pay attention to in this connection.

Iron can be obtained for fastenings, including the strapping, of wood ships; and it is much preferred to steel by at least one of the classification societies on account of its greater

resistance to corrosion. Where inside fastenings not in contact with salt water are allowed to be black, if of iron, the same items in steel are required to be efficiently galvanized. This includes the strapping between the frames and outside planking, the galvanizing of which is sometimes a difficult matter on account of the long lengths to be dealt with.

Iron rivets can be obtained and should be used with iron plates when in contact with water. When used with steel plates, however, in contact with salt water, electrolytic action sets up a rapid corrosion which renders their use under such circumstances decidedly objectionable. It is the same action that takes place in marine boilers when not well equipped with zinc plates.

The electrolytic action above mentioned is much more marked when bronze propellers are in use on steel ships, or where composition sea valve connections come through the shell in contact with the sea water. To prevent the rapid corrosion of the steel in such cases, zinc plates should be ordered for application to the stern frame or plating in the region of the composition casting. The electric current will then pass through the water from the zinc to the bronze instead of from the steel to the bronze.

A marked corrosion may be expected wherever the fibres of the material have been severely stressed. This has been referred to previously in connection with the use of joggled shell plates.

Another point to be borne in mind is to not have steel studs and nuts for tank manholes, stuffing box glands and other similar service where subject to corrosion. The stud can be of composition and the nut of steel, or vice versa; but in the latter case the nuts will be much more subject to mysterious disappearance.

Cast Steel

This material has come into extensive use for stern frames, rudders, anchors and chain cables, deck fittings, crank webs, crosshead slippers, bearing boxes, short pieces of curved piping, and a great variety of work about a vessel. With this material, even when made under good specifications, and the castings properly handled and annealed, shrinkage cracks are apt to develop in large castings; but the troubles from this source have been greatly reduced by the growth in successful application and classification favor of the several kinds of welding.

With cast steel frames, cracks which ultimately result in fractures are most apt to develop at the junction of the propoller post and shoe; and with single screw steamers it is a wise precaution to have scarfs that will admit of the renewal of the lower part of the frame without removal of the propeller shaft boss and the upper part around the overhang.

Semi-Steel

This material is used for propellers, gear wheels, base castings and other work about a vessel. A quite usual formula is:

	Percent
Pig iron	50
Cast iron scrap	25
Steel scrap	25
	100

which should produce a material having a tensile strength of about 30,000 pounds per square inch. Some manufacturers use as much as 40 percent of steel and turn out a material that has a tensile strength of from 35,000 to 40,000 pounds per square inch.

Semi-steel is not a suitable material for rail stanchions and other items of small cross sectional area in proportion to their length, as it has not the requisite ductility.

Malleable Cast Iron

This material is a kind of crude wrought iron produced from cast iron by subjecting the castings to a process which removes a large part of the carbon. The process takes several days, even for castings of small size; the shrinkage is considerable; sharp angles have to be avoided; and there should be as much exposed surface as possible. It is of value for rail stanchions, hatch cleats, portable hatch stanchions and sockets, clinch rings and small castings generally, where cast iron would be too brittle or too cumbersome; although its field is limited by the availability of cast steel.

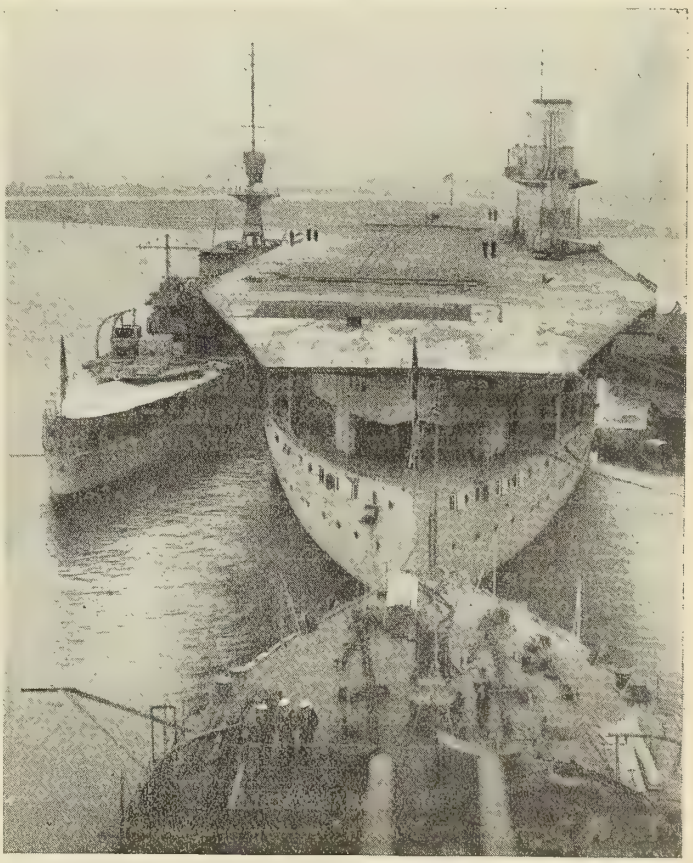
Cast Iron

The chief point to look out for when ordering cast iron is to secure castings that will be easily machined and free from blow holes. This is not altogether either a matter of the formula or of allowing the casting to cool properly. Some manufacturers have the knack of and reputation for turning out castings that other manufacturers do not appear to be able to produce. So a knowledge of the product of the maker of iron castings is of value. This is particularly the case for cylinder castings, propellers and other items where the quality of the material is highly important.

A peculiarity of cast iron is that it grows with repeated heating and cooling. Castings which form bearings for pins, shafts, etc., when loose in the bore can be sometimes *shrunk*, or reduced sufficiently in diameter of bore to be serviceable, by a single heating to a white heat.

There are a number of special mixtures or alloys of steel made by the addition of one or more of the metals—nickel, chromium, manganese, or vanadium, and also special mixtures and products of iron; but they all have their definite chemical compositions, properties and uses and call for no particular mention here.

Flying Deck of H. M. S. Eagle



View of the Stern of the Vessel

As shown by the above photograph of the flying deck of H. M. S. *Eagle*, the funnel of the vessel is at one side, so as to give space for the aeroplanes alighting or leaving. The part of the flying deck over the stern of the ship is sloped to give impetus to machines leaving, and to act as a brake to machines landing.

Fairing Ships During Construction

Hull Construction Methods Used at the Harriman Yard of the Merchant Shipbuilding Corporation

BY W. M. KENNEDY*

CONSIDERABLE trouble was experienced with fairing and regulating the earlier ships constructed at the Harriman yard of the Merchant Shipbuilding Corporation, which resulted in an unusual number of plates being lost through bad rivet holes.

In the beginning this bad work was laid to poor regulating, and in an attempt to raise the standard of this department the best available men were assigned to assist. No improvement, however, resulted, and a check was next made at different points throughout the ship and the true cause of the trouble found. It proved to be fairing. Exceptional care was then given to fairing work by shipwrights in the old way in an attempt to overcome the abnormal loss of material, but the desired effect was not forthcoming.

At this time it was suggested that a transit be employed for checking up. As usual, such innovations were not taken very kindly to by those in charge of a particular line of work, but in a very short time the advantages of this method became apparent and all concerned were giving their best efforts to devise additional checking points. The effect of this careful checking by the use of a transit resulted in better work and less material loss through condemnation.

Checks Performed During Construction

The final procedure adopted to insure the fairness of a ship during construction follows:

(I) Preassembly

1. (a) Supports for keel undergoing preassembly are lined and graded.

(b) Supports are checked before a new keel is laid down in preassembly from control stakes under each horse of the berth.

2. The bolted keel is checked in its entirety before being riveted.

3. Stern frame is checked before being chipped.

4. Stern frame is checked after frames and plates are bolted on.

(II) On Ways

1. Keel blocks are set before laying of keel.
2. Keel is checked from control points underneath.
3. Floors are checked for height at outboard end in relation to base line.
4. Bulkheads are checked for line and grade after being bolted in place by side shell plating.
5. Stern frame is checked after being bolted.
6. Launching ways are set.
7. Hog or sag of vessel after being launched is determined.
8. General remarks.

Methods Used for Checking

The methods used for carrying out the above checking procedure are as follows:

(I) Preassembly

1. (a) Supports for keel undergoing preassembly are lined and graded.

The supports which occur at approximately 10-foot intervals are originally brought to a true centerline and a true grade line, each bent being leveled up as well.

(b) Supports are checked, before a new keel is laid down in preassembly, by control stakes.

These control stakes are driven flush with surface of ground at each support.

The line is set directly on each stake and the grade is referenced by a tack in the side of each stake so that the keel can be checked even though the supports are moved.

2. The bolted keel is checked in its entirety before being riveted.

By plumbing up from line in control stakes and measuring from the grade nails in control stakes, the keel is faired to prevent the difficulty of bringing the assembled sections to the line and grade when placed on the keel blocks.

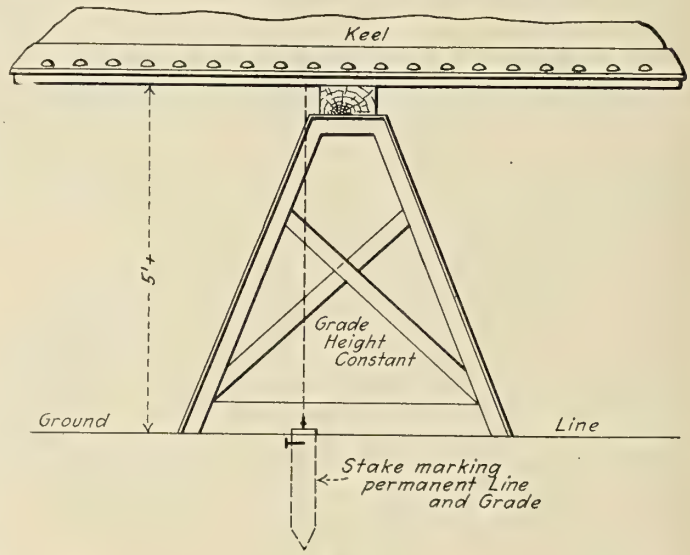


Fig. 1

3. Stern frame is checked before being chipped.

(a) After the rough castings are laid down in the preassembly space, the stern frame template is applied and a line which most nearly parallels the rudder post and the upper and lower palms is marked on the sides of the castings, usually the line of No. 1 frame.

The 6-foot waterline is transferred from the template to the casting at this time, due consideration being given to (1) fitting to the shoe of the frame to reduce chipping to a minimum; (2) fitting to the center of the boss to facilitate drilling and keep enough metal on all sides; (3) landing on the palms.

The reason for marking the 6-foot waterline is to establish a pitching spot or bench mark from which to fix the vertical position of the stern frame later. A tolerance of an inch or so above or below the designed line of shafting is often allowed, and this tolerance permits the stern frame template to be juggled a little with a view to reducing the chipping to a minimum, etc., as noted above.

(b) A base line, squared with the line paralleling the rudder post, is then established at the lower end of the casting and the 6-foot waterline is then corrected to parallel this base line, the corrected position being marked for future use when placing the stern frame in position on the ways.

It sometimes happens that after the base line is established the shoe of the stern frame is found to be warped in a vertical

* Assistant works manager during construction.

direction and out of square with the rudder post. When such is the case correction by heating is necessary.

The scarph line for the offset to take the keel is then located from the base line and the casting chipped as required.

Caution might be added here against working on a casting when it is out of a horizontal plane, remembering that if the forward end of the shoe is out of the plane and the top of the palm also, the plane of the stern frame will not be square even though the post is square to the base.

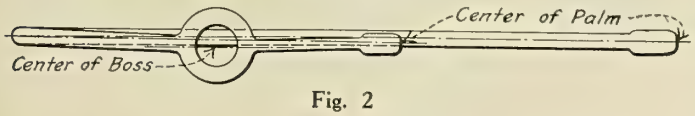


Fig. 2

(c) A test should always be made to determine whether the centers (considered athwartship) of the boss, the palms, the foreward and after ends of the shoe are in a plane.

These points must be brought to a plane (by heating the casting, if necessary), else when the stern frame is erected they will not coincide with a vertical plane through the center of the hull.

This work should be done by the carpenters principally, as it makes for simplicity of operation in the field.

One method of doing this is to clamp 4-inch by 4-inch wooden posts at the several above-mentioned points, the 4-inch by 4-inch uprights being nearly vertical when the frame is horizontal.

Points at an equal distance above center (athwartship) are then taken on the uprights and these points connected with a line drawn taut. By sighting over the lines a quick survey can be had and any necessary corrections made.

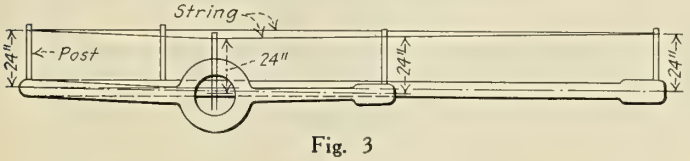


Fig. 3

(d) If heating is necessary either for squaring (operation 3b) or for bringing to a plane (operation 3c), the casting is again checked for both operations.

4. Stern frames are checked after frames and plates are bolted on.

(Note) The practice is to rivet the shoe plate, boss plates and other strakes which are riveted to the stern frame while the frame is in preassembly.

The shoe plate is checked for squareness (operation 3b) by a transit before riveting, also for plane (operation 3c). This is accomplished as follows:

The shoe plate, or aftermost keel plate, is bolted to the stern frame and stern framing forward to and including the afterpeak bulkhead, which is then bolted in position. After the frames are set in place the shell plates (other than the boss) are bolted to the frames and clamped to the stern frame. The assembly is then checked by measurements to heel of frame and by a transit to insure that the shoe plate is square to the rudder post and also that the centerline of the palms, boss and bulkhead lay in the center plane of the vessel. The plane of the transit is brought to coincide with the stern frame and the structural assembly adjusted until the centerline of the bulkhead falls in this plane, the clamped connection to the stern frame forming a slip joint makes this adjustment possible. The boss plate is then set in place and the entire assembly riveted.

(II) On Ways

1. Keel blocks are set before laying of keel.

Three battens are set from control nails in the stringers—one near the bow, one amidships, one near the stern. The transit is set over the one at the bow or stern, tide and direction of light determining which one is used.

A sight is taken on the batten at the other end, checking on the midship batten and the rake and the grade established. Other battens are then set at 20-foot intervals (a total of 20 battens for a 400-foot vessel) each being adjusted to the bottom of the flat keel, leveled up athwartship with a spirit level and marked with centerline.

(Note) As soon as two battens are set, the carpenters erect the keel blocks and stretch lines, marking the amount to be dressed off the top keel block, which is then taken to a band saw to be cut. It is then replaced while other carpenters mark the centerline with a saw cut. This centerline is brought to a line stretched over the battens and the block secured in place.

This releases skilled mechanics from adzing, which is slow, and concentrates them on laying off the blocks and centering same, which operation follows closely on the setting of each successive batten.

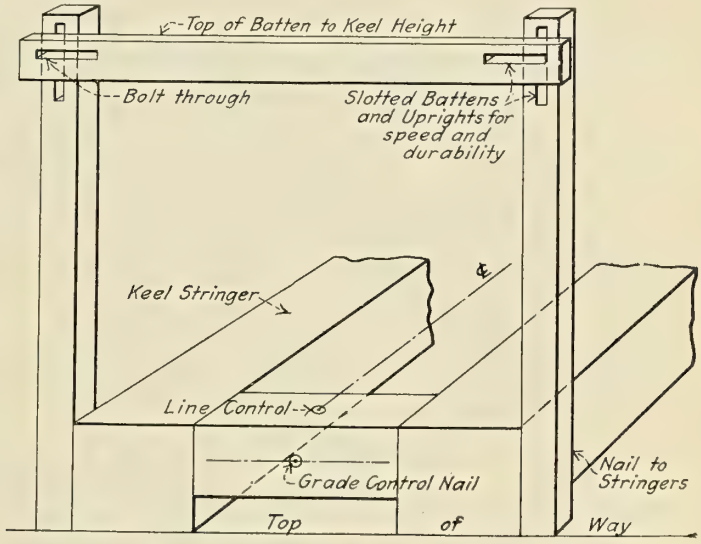


Fig. 4

2. Keel is checked from control points underneath.

After the keel is laid and shored in place by carpenters it is checked by an engineer from the control points underneath.

This is of particular advantage in offering a ready way of holding the hull to line and grade as the work progresses, as well as for projecting the line and grade for boring out the boss and giving grade from which to locate the draft markings.

3. Floors are checked for height at outboard end in relation to base line.

Floors are tested for squareness with centerline at sufficient intervals to control their spacing at the outboard end.

The floors, having been regulated to the vertical keelson, are next leveled to bring the outboard end in correct relation to the base line of the hull.

The keel having been already checked and regulated, battens are run out to the side of the ship in way of the floors selected and leveled with a spirit level to the under side of the keel. Dimensions furnished by the mold loft give the deadrise of the floor in question, permitting the outboard end to be set in proper position. The intermediate floors are then placed in position and adjusted with a transit by establishing a plane above the outboard ends of the floors leveled as above.

4. Bulkheads are checked for line and grade after being bolted in place by side shell plating.

The bulkheads are controlled by shores and wire stays, as well as some bolts through side shell plating.

By placing the transit on the centerline on the tank top and picking up the centerline, it can be checked at the second and upper decks and even to the bridge without the necessity of

being held up by the oscillations of a plumb bob, as is the case when this method is used.

In plumbing on the after side of a hatch it is possible to hang a plumb only from the upper deck to the second deck in one operation, due to the declivity. A separate operation is necessary to plumb from the second deck to the tank top. The transit does this more expeditiously and more accurately and it is the only possible way to plumb the entire distance in one operation.

Results on bulkhead plumbing for line are checked by leveling on the "waterlines," which are located on the face of the bulkhead.

5. Stern post is checked after being bolted.

The stern post is checked for line and grade by placing the transit on the centerline aft of the stern of the ship about 30 feet. Lines and grades are picked up from control nails and the stern assembly is then brought to accurate line and grade without the necessity of plumbing, which operation is difficult for such a length when the weather is at all windy.

6. Launching ways are set.

Battens are set at approximately 40-foot intervals from the inboard end of the ground ways, extending to the inboard end of the seaways. These battens are set from the same system of control nails which governed the keel block battens.

Particular care should be exercised to check the seaways as each set of launching battens is set. This is a safgeuard against any tendency to irregularity or failure of seaways. The entire length of seaways is tested immediately after each launching to determine any tendency to failure. An imperfect joint, such as a summit in the grade, at the junction of the ground ways and seaways, or any sinking of seaways, is thus predetermined and corrected by carpenters, if dangerous.

7. Hog or sag of vessel after being launched is determined.

On the day before a launching the transit is set up on the upper deck just aft of the forecastle deck house. A line parallel to the deck is projected to the forward face of the after deck house and chiseled in. When this line is established rods are read at every fifth frame. This produces the profile of the deck, which profile is used as a comparison with the profile obtained in a similar manner after the vessel is launched.

In addition to the deck profile, a profile of the shaft alley is taken and compared.

8. General remarks.

It should be borne in mind that the prime necessity of this method is to facilitate construction by greater accuracy of fit among the several parts of the hull and the determining factor in calling for accuracy of regulating of these parts is not how closely they can be surveyed and brought to line and grade, but at what point accuracy in regulating costs more to obtain than it returns in saving in the other lines of work, equality of finished product being maintained as the first requisite and speed of construction being borne in mind.

Endeavor so to plan the checking of any hull that mistakes are anticipated and not exhumed.

Work in close conjunction with the shipwrights; their views are often most comprehensive of the entire crankiness or fit of the hull in question, and in them lies the control and corrections.

Relation of Portable Tools to Building Berth

Number of Tools Required for Building Ways and Wet Basin—Location of the Tool Rooms and Care of Tools

BY MAURICE NICHOLLS

DURING the years of 1917 and 1918, when shipyards were springing up over night, the first problem that presented itself to the management, after the site had been selected, was the question of the number of tools. Due to the fact that no data had been made public along these lines, tools were bought largely on guess or by a limited comparison with other yards then in operation. As a direct result of this, many yards overstocked themselves, while others went to the other extreme.

The problem which now confronts the yards that have survived the war building programme is, how many tools do we really need? At first thought it would appear that this question cannot be approached with any degree of precision due to the fact that each governing factor is a variable, the factors being "*A*" size of ship, "*B*" number of ships under construction at one time, and "*C*" the type of ship. It is evident that each of the above has a limit. Factor *A* is limited by the size of the building way and *B* by the number of ways in the yard. The type of ship requiring the maximum number of portable tools is the tanker type. This is evident because of the additional bulkheads and the extra watertight work. These cases form the upper limits of the variables. At the same time, consideration must be given to the fact that there probably never again will be a time when each yard, the country over, will have a ship for each building berth. Prior to 1916 a yard with five building ways was large, and it was nothing short of phenomenal if all of the ways were occupied at the same time.

From the standpoint of the work on the Great Lakes, the limit of factor *A* may be safely put at 650 feet. During the war the Lake yards were busy with vessels 261 feet in length, which is the maximum length unit that can be brought down to tide water. The 650-foot vessel is, in all probability, the upper limit of the modern Lake freighter, although there is in operation today one vessel 635 feet in length.

Turning from the Lakes to the coasts we find that vessels were projected varying from tugs 150 feet in length to the new battle cruisers which measure well over 800 feet. However, 800 feet in length is what might well be termed unique in the annals of shipbuilding in this country, and it was only after alterations were made that one or two private and government yards could undertake to build this size of vessel.

From a review of the contracts pending for 1921 it will be safe to estimate that 98 percent of the vessels to be built will not be over 500 feet in length.

TOOL ROOM

One of the most important items in the consideration of portable tools is the location of the tool room. Many yards have located their tool rooms so that they are readily accessible from one building berth while they are at a decided disadvantage from the remainder. Based upon actual studies made by the writer in several yards on the Great Lakes and east coast, the time consumed for a round trip from the building berth to the tool room ranged from fifteen minutes to one hour and seven minutes. These were not made on any special hurry trips, but the ordinary trips a workman makes during the day—no doubt each trip accompanied by the usual side

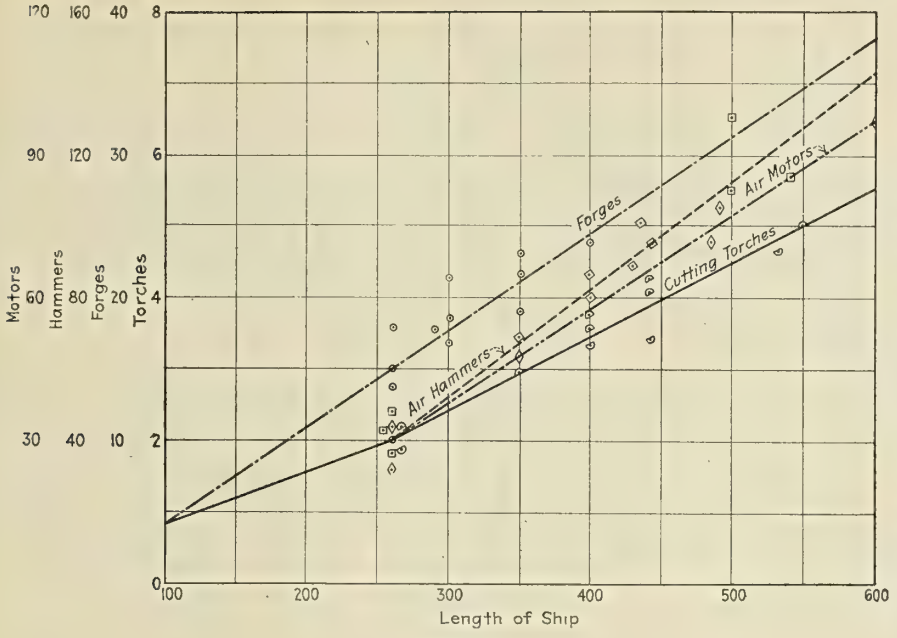


Fig. 1

trip to the toilet or drinking fountain. Even the minimum round trip time multiplied by the number of trips per day from a ship gives a result almost unbelievable. This is lost time.

Sub-Tool Room at Head of Ways

A sub-tool room maintained at the head of each or each pair of building berths will be a great aid in reducing this loss. These sub-tool rooms may be designed to be portable, sling attachments being provided to permit handling with a traveling crane, the idea being to only issue tools and to keep on hand only those tools that are in first class shape, the tool maintenance being taken care of in the central tool room.

It will not be necessary to keep at all times the entire number of tools allotted to the ways in question. The number of tools required per week can be obtained from the foremen of the various crafts in advance. For example, the bolter foreman notifies the sub-tool man that by the end of the week sixty gangs of bolters will be on the ship, and the sub-tool man arranges his stock so that if a tool is broken or out of commission it will only be necessary to go to the sub-tool rack and have the exchange made.

Portable Tool Requirements per Way

In order to visualize the tool requirements per building way, the writer has prepared several curves. These curves comprise the important portable items used on each way and are plotted to the length of ship. As no information has been gathered on vessels exceeding 600 feet in length, the curves are not extended beyond this length. These curves have not been drawn to any special type of vessel, but form the mean between the types requiring the maximum and minimum portable tools, i. e., tankers and general freighters. It has been demonstrated on the east coast, however, that tankers have been built size for size with freighters with only 5 percent additional tool requirement per way.

Considering the curves in Fig. 1, the term forges is applied to the ordinary pea coal rivet forge and the term hammers to riveting and holding-on hammers. Hence, the first point 40 means 20 riveting guns and 20 holding-on guns. The calking guns are read from the same curve, but also include the tools used by the test gang. Thus point 40 on the 250-foot vessel denotes that 40 calking hammers will be required, divided among the day workers, piece workers and the test gang. The curve for gas cutting torches is self-explanatory.

No curves are plotted for riveting dies, reaming or countersinking tools. These stand in the ratio of 5 to 1 with the machine they are used with. For example, on a 350-foot vessel the maximum number of riveting hammers multiplied by 5 gives the number of riveting dies per way. The ratio of chipping and calking tools is figured in a similar manner using the ratio of 8 to 1. Welding torches are in the ratio of 1 to 2 with the cutting torches; however, the same cutting operator can handle this work if care is used in the selection of men. One electric arc welding machine should be provided for vessels up to 275 feet in length and two per way for vessels up to 500 feet. Oil heating torches should be provided two per way.

Fig. 2 shows plotted curves for wrenches, goggles and lineal feet of air hose. While these curves are plotted from actual shipyard figures, good results may be obtained by the following method. The maximum number of bolters used on a certain type of ship can be readily determined and this number multiplied by four will give the total wrench requirements. Regarding the number of goggles per way, each welder, burner, grinder, chipper and calker and three out of every five riveters must be supplied, the surplus noted on the curves being used to handle the miscellaneous cases.

The maximum lineal feet of air hose per size of ship varies for each yard due to the fact that each yard differs somewhat in the method of supplying air at the building berth. This curve has been drawn as a mean and does not include hose for work at the assembly ground.

Surplus Tools

After the consideration of the number of tools required per way the question of surplus tools at once presents itself. The proper surplus to allow varies greatly dependent on the care exercised by the men using the tools.

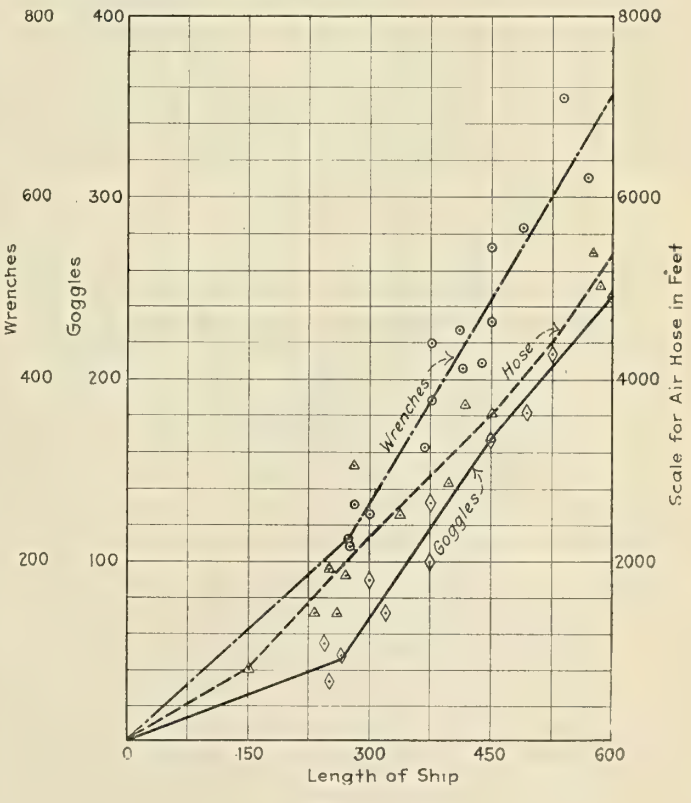


Fig. 2

To much emphasis cannot be placed upon the proper maintenance of the portable tools. The actual treatment of the tools, however, varies greatly according to the district and the class of men employed.

CARE OF PORTABLE TOOLS

In regard to the treatment of tools, a craftsman becomes attached to a tool by use, and, recognizing this fact, the best results can be obtained by re-issuing the same tool to the same individual as far as possible.

Several yards, in order to bring out this point, offer a tool prize which is awarded monthly to the man who keeps his tools in the best shape. This scheme stimulates an interest in the care and upkeep of tools, relieves a big burden from the tool repair room and has accomplished good results in connection with welding, burning and electric welding machines and also small tools such as wrenches, dies, etc. The principal criticism against this plan is that it takes men from their work, the men working on their tools when they should be working with them. A piece worker is after the money, and it is to his advantage to have his tools in such shape that he can produce the most work during the working period. Any person who has been a foreman or superintendent will admit that there is a lot of commotion if the tools are not in proper shape. On the other hand, there is the question of the employee on day work. It is this class of workmen who are the most destructive. Out of a hundred consecutive "breakdown" cases presented at a window of a tool room, eighty-four were at the hands of day workers. Another random case based on the breakdowns submitted from one building way showed that seven out of ten were from day workers. The success or failure of this tool maintenance prize rests, to a large extent, with the sub-foremen and gang leaders.

Another way of preventing lost time and at the same time adding to the life of tools is to have a tool repair man assigned to one or two berths. This man carries a portable tool repair kit, oil and grease and makes the rounds of the men on the ship, attending to minor repairs, oiling tools and approving the necessary trips to the tool room. This scheme eliminates trips to the tool room for minor repairs and has proven very successful due to the fact that workmen, especially day workers, take advantage of the slightest defect to take a walk to the tool room.

By providing a portable tool grinder at the sub-tool room when work is started on a berth, considerable time is also saved. As construction proceeds one or two of these tool grinders should be placed on the ship itself.

TOOLS FOR THE WET BASIN

In all of the above discussion consideration has been given only to the building ways. The question of the wet basin or finishing pier presents considerable more difficulty due to the fact that vessels are launched in all degrees of completion. Several cases are on record where vessels were launched riveted only up to the light load line, and, taking the other extreme, vessels have been launched complete even to steam. In view of this there is a great range of tool requirements. The percentage of completion for launching varies according to the demand for room for new work, contract requirements and miscellaneous requirements.

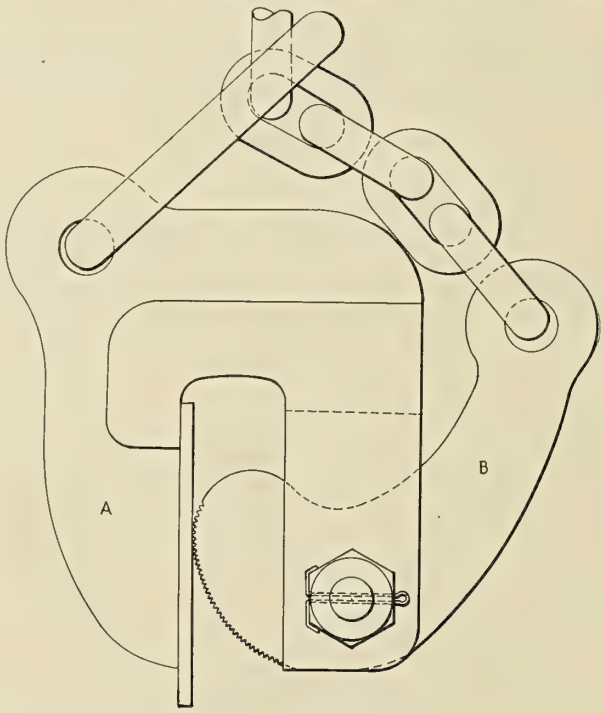
It is not necessary to establish a separate account of tools for the wet basin or maintain a running surplus for portable hull department equipment if the tools are proportioned to the building berths. The tools necessary to complete the vessel should be carried over from the building berth. It is evident that before the maximum number of men can be employed on the keel which is to be laid the work involving the use of the same tools will be completed on the ship just launched. This is true only in normal times and cannot be used where a large contract of sister ships is to be turned out under war pressure, as one glance at the fitting-out basins of the yards during war times would show.

It must be borne in mind, however, that the largest tool losses and greatest percentage of breakage occur at this stage. This is due in a large measure to the fact that small tools are thrown to one side and soon covered with débris incidental to the work at this point in the construction. Two percent of the larger portable tools should be added to the total tools per building way to cover this loss, and from 5 to 8 percent on smaller tools such as wrenches, dies, dollies, etc.

The Comrie Safety Hook

AN ingenious safety hook for the efficient and safe handling of plates has been designed and invented by Alexander Comrie of the Standard Shipbuilding Corporation, Shooters Island, N. Y., for handling material in that yard. The hook grips plates through friction the moment the pull is exerted by the overhead crane and has been found to increase the handling efficiency. This device is now in use in other shipyards in the New York district.

Referring to the illustration, the hook consists of the jaw *A*, which takes the plate or plates, and the tongue *B*, to which



Sketch of Safety Hook

is attached the chain leading to the crane and swings up when the pull is exerted, gripping the plates fast. The hook will lock itself on the load irrespective of the direction in which the pull is exerted and two or more plates can be handled at one time with equal facility.

A load of sufficient weight to bed the teeth of the tongue piece into the surface of the plate, for instance, a load of from one-half ton up, could not possibly become disengaged by slacking of the tension on the lifting chain. The gripping strain is about four times the load weight and the locking strength so great that the tongue usually requires to be tapped loose after landing the plates in the position desired.

LAST SHIPPING BOARD KEEL LAID.—Of the 2,312 ships built or building for the Shipping Board, there remain 50 vessels of 407,412 gross tons under construction still to be delivered, the keel for the last of these being laid March 17 at the plant of the Northwest Steel Company, Portland, Ore.

The Modern Cargo Vessel*

BY WILLIAM GATEWOOD †

Civilization is made possible by commerce, and as commerce cannot thrive without suitable means of carriage, the humble cargo vessel is the handmaiden of progress. The cargo vessel, like so many other institutions, has been an evolution and the type of vessel has adapted itself to the needs of the day and generation. How the modern cargo vessel has been evolved to meet the present day needs of commerce is shown in this paper.

THE modern cargo vessel is built of mild steel, is propelled by a screw propeller operated generally by steam machinery, is steered with a rudder operated by steam and controlled from the bridge, is navigated by magnetic compass, has its location determined by chronometer and sextant, and has its cargo handled by block and tackle from booms on masts or derrick posts by means of steam winches. The size, arrangement, speed and fuel are specialized to suit the exact requirements of the trade, and few trades call for exactly the same design.

Cargo Vessel of the Future

The cargo vessel of the future may be built of high tensile or special steel but there are no indications at present that mild steel will be superseded in the near future, except on the largest vessels. It may have some other kind of propulsion than by a screw propeller, but there are no indications of any more efficient method, although some improvements may be made in the type of screw. The reciprocating steam engine is being superseded by the geared turbine, and the turbine is being used also in conjunction with electric generators and motors, instead of gears. The watertube boiler for generating steam is now becoming almost as well known as the cylindrical boiler, and the majority of new vessels use oil as fuel instead of coal. The internal combustion Diesel engine is being developed and used, and it is possible that this will be the prime mover of the future on account of its economy, unless oil becomes too expensive to be used at all. Electric motors are well suited for operating any type of steering gear, including hydraulic, and when steam is not used for propulsion, electric auxiliaries are the natural arrangement. The gyro-compass may replace the magnetic compass, as the gyro-compass is now used on Atlantic liners and in the Navy. The variation of the magnetic compass, first discovered by Columbus, is still a source of confusion, and the deviation of the compass due to the ship's magnetism is a continual cause of anxiety to the navigators. No substitutes for the chronometer and sextant are being experimented with, so far as I know, but the "wireless" is already being used to give the location near the coast in a fog, and to check the time. Electric winches are common on naval vessels and are used also when internal combustion engines constitute the propelling mechanism.

> We are interested in the modern cargo vessel as an efficient instrument for the carrying of the world's commerce and for the advancement of civilization, and also from a national viewpoint as a means of maintaining and protecting the independence of the United States. For this latter purpose, no minor sacrifice should be allowed to overshadow the great gain in independence which will result from our ownership and operation of a large fleet of modern cargo vessels.

Concrete Ships Generally Impracticable

Reinforced concrete is being used in the construction of cargo vessels to a limited extent. The aggregate used weighs much less than that used in land construction, so that the concrete vessel is not so very much heavier than the steel vessel. Concrete, however, is liable to develop cracks under tensile stress, and the sides seem to be susceptible to damage in docking. It does not seem likely to be much used for ship construction in the future. In a well designed steel vessel of large size, almost all of the steel is required to withstand tensile stress, and so no reduction in the amount of steel used for reinforcement could be made, as the concrete is of value only in compression. The weight of the concrete must be almost entirely in excess, therefore; and the reduction in cost of construction, if any, can hardly be great enough to offset the loss in deadweight.

The size of a cargo vessel is made to suit the length of voyage and the amount of cargo available. There is no economy in having a large vessel in a given trade unless the vessel can be fully loaded on most of her trips. The commercial life of a vessel may be taken as 20 years, and a depreciation of at least 5 percent per annum on the investment should be allowed as a part of the cost of operation. Not less than 5 percent interest on the investment should be gained in addition, and repairs will amount to an average of not less than, say, two percent of the first cost, so that not less than 12 percent of the first cost must be carried each year in addition to the cost of operation. The first cost, therefore, is of prime importance in determining the particulars of a vessel. Other things being equal, the cost increases with the size, and therefore the vessel should not be larger than the amount of cargo justifies.

Economical Size of a Cargo Vessel

The economy in operation resulting from increase in size, however, is very great. It takes very few more in the crew to man a vessel of 10,000 tons than to man a vessel of 5,000 tons, as the same number of licensed officers are required on each vessel and only about six additional men are needed in the crew. The horsepower required for the same speed is increased in the larger vessel by only about 50 percent, and the machinery may be made somewhat more economical so that the fuel consumption will be increased by less than 50 percent. If the operating costs of crew, fuel and supplies amount in the course of a year to 30 percent of the first cost in the case of the smaller vessel, they would amount to only about 24 percent in the case of the larger vessel.

The larger vessel would carry about 2¼ times as much cargo in the course of a year, as the machinery and fuel would occupy proportionately less space and weigh proportionately less, and the number of voyages need not be less, as the slight increase in the time in port, if any at all, would be counterbalanced by the less interference with regularity of speed on account of bad weather.

The first cost of the larger vessel would be considerably less than double that of the smaller vessel, on account of the fact that the weight and cost of the hull and fittings is not

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twice as great and the cost of the machinery would be only about one and a half times as much. The first cost may be taken as about 1.8 times as great.

The advantage of doubling the size of a vessel, then, may be summarized as follows:

The carrying capacity of the larger vessel will be about 2¼ times as great.

The operating cost of the larger vessel will be about 36 percent of its first cost when the operating cost of the smaller vessel is 42 percent of its first cost.

The first cost of the larger vessel will be about 1.8 times the first cost of the smaller vessel.

The comparative cost of operation of the larger vessel per ton of cargo will be only about three-quarters as much as the similar cost for the smaller vessel.

Effect of Increased Speed

The natural thought would be that by increasing the speed of a vessel quite an advantage would be gained. Such is seldom the case, however. If a vessel, for instance, has a speed of 9 knots and spends two weeks at sea to one in port, the first cost of a vessel to carry the same weight of cargo each trip would be nearly double for an increase in speed of 50 percent, and the cost of operation would be at least double, while the faster vessel would carry only 30 percent more cargo in the course of a year. It is this economic fact which keeps the average speed of cargo vessels so nearly the same as it was twenty years ago. The tendency in this country, however, is to build for a speed of between 10 and 12 knots, and few vessels are being built of less speed than 10 knots. The effect of bad weather is much greater on the slower vessels, and the increased length of time the cargo is in transit operates to reduce the freight rates. It is generally conceded that only vessels for carrying passengers and express freight should be designed for speeds in excess of 16 knots, and quite a number of passenger vessels are running at a speed of about 14 knots. The larger the vessels the less the economic disadvantage in the higher speed, as the power required for the same speed does not increase directly as the size of the vessel but only as about the two-thirds power of the displacement, and a somewhat higher speed can be obtained without using as great a proportion of the displacement for machinery and fuel.

> The great problem before this country at present is not a lack of vessels, but a lack of experienced operators to manage the vessels. Any marine policy which overlooks this fact is doomed to failure. The difficulty of the task, however, should not deter us from tackling it in earnest, and the nation which bore the honors in shipping a century ago is doubtless able to repeat its performance at the present time.

The Block Coefficient

The underwater form of a vessel may be made quite bluff, if a low speed is deemed sufficient, but the lines must be made finer as a higher speed is sought. The block coefficient is the term used to denote the proportion which the volume of the vessel under water bears to the circumscribed parallelopiped. For a speed of 10 knots the block coefficient is about 80 percent in a vessel 400 feet long, and may be increased to 82 percent in longer vessels, while it would be reduced to 78 percent in a vessel 350 feet long. It ranges between 78 and 82 percent in the ordinary cargo vessels. As the speed increases, the block coefficient is reduced, and in some recent freight and passenger vessels 518 feet long and designed for a speed of 16 to 17 knots it was made as small as 65 percent.

The high cost of construction of the hull, and the broken stowage, however, do not recommend such a fine block even though a higher speed is obtained for the same power. Bad weather reduces appreciably the speed of a very fine vessel, causing heavy pitching, so that a vessel should be neither too bluff nor too fine. The present tendency on cargo vessels is toward a fining of the bluff bows which were so common earlier in the century, and also toward fining the stern, not only to preserve the trim, but also to give a better flow of water to the propeller and to gain in efficiency of propulsion thereby.

Sheer

The above water form of hull of modern cargo vessels provides usually a flaring bow in order to prevent the waves from breaking over the deck, a smooth sheer line with about twice the rise forward as aft, with erections to suit the needs of the service. In most of the fabricated vessels, there is no sheer at all, but such vessels are not as good sea boats, and under the present rules for determining freeboard they cannot load as deeply. Many vessels have been built in this country with a straight sheer for the half length or more amidships and with a quick sheer forward and the usual amount of sheer aft. This practice simplifies the construction, increases the strength somewhat, and does not offend the average eye. It will probably come into more general use, especially when the rules for determining freeboard are made rational instead of empirical.

Vessels with forecastle, bridge and poop are still the most common, although the shelter deck type is coming more into favor. The latter provides more cubic space for the same weight of cargo, and is better adapted for general cargo on that account.

The submarine is not likely to be a competitor with surface vessels in the carrying of cargo, as all the troubles of surface vessels are magnified greatly when the complications of running submerged are added to the navigation on the surface.

If a vessel is not always sure of a return cargo, and has no means provided for a large amount of water ballast, the machinery is usually placed amidships. This is the common type. In oil tankers, colliers, and a few liners, including some vessels carrying passengers, the machinery is located aft, and this type of vessel is becoming quite numerous. The midship portion of the vessel is the best for carrying cargo, while the machinery fits very nicely in the stern, and the troublesome shaft alleys are avoided.

Location and Types of Machinery

The type of steam engine installed on most cargo vessels is the inverted vertical three cylinder triple expansion reciprocating engine. This type has been in use for about forty years, the first successful one having been installed in 1881 in the *Aberdeen*. It has been improved in details, and the ratio of expansion has been increased as the boiler pressure was raised, but it is essentially the same machine and engineers have become so accustomed to it that a breakdown in service is almost unknown. A number of four cylinder triples are in service, and the four cylinder quadruple engine is quite common in liners, and very economical.

The geared turbine was introduced in cargo vessels in 1910 by Sir Charles Parsons on the *Vespasian,* as the only method of using steam turbines on slow speed vessels with any economy. The modern gears are not of the same type as were used sixty years ago in the *Great Eastern,* for instance, but are of steel cut with the minutest accuracy. A high speed of revolution is necessary in order that a steam turbine shall function with economy in the use of steam, while a slow speed of revolution is necessary in order that the propeller shall be efficient. A gear ratio of 15 to 1 is about the average for a single reduction, while a ratio of between 30 and 40 to 1 is used with double reduction gears. Both the Curtis and Parsons type of turbines are in common use, but neither

has displaced the reciprocating engine as yet. So many are now in use that the reliability of both the turbines and gears will be determined shortly, and as they weigh less, take less room and have possibilities of economy greater than the reciprocating engine, they seem sure of an extended use in the future.

Electric propulsion was introduced on the naval collier *Jupiter* in 1913 by the General Electric Company and has recently been fitted on merchant vessels. In this system of propulsion, an electric generator is driven by a high speed turbine, and the propeller is operated at a suitable speed by a motor. The steam consumption is very moderate, and some eminent marine engineers in this country consider that the electric drive is one of the coming forms of propulsion for cargo and passenger vessels. It is slightly heavier than the reciprocating engine and much heavier than the geared drive, and probably will prove more expensive to build, so that its future use will depend on how well it can overcome these handicaps in the course of its development.

The internal combustion oil engine for marine use was introduced in Italy in 1910. It has been developed up to units of slightly over 2,000 horsepower, and its consumption of fuel oil is reported to be only half as much as in the best form of steam machinery. In its present state of development, it is considerably heavier than steam machinery of the same power. The earlier installations have not always proved reliable, but as experience has been gained in its design, construction and operation, it has given greater satisfaction in service. At present, its first cost is considerably in excess of steam machinery, and the power of a single unit is limited, so that it offers no immediate advantage financially except on long voyages on which the saving in the fuel supply needed will enable a heavier cargo to be carried. A recent American installation is that on the *Cubore*, which came out in the summer of 1920.

Boilers

The use of steam machinery for marine purposes was handicapped until the cylindrical multitubular boiler, commonly called the Scotch boiler, was developed in about 1862. As the steel mills became able to roll larger and thicker sheets, this type of boiler increased in size and ability to carry heavier steam pressures, so that one single ended four-furnace boiler 17 feet in diameter can now be built to generate steam at 200 pounds per square inch sufficient for an indicated horsepower of 1,200 or more, although three-furnace boilers for a working pressure of 160 to 180 pounds are the common size. This type of boiler can be used to burn either coal or oil, and, like the reciprocating engine, is so well known that a breakdown in service is rare, although repairs on account of carelessness are not as infrequent as they should be.

The watertube boiler was introduced in the merchant service about 25 years ago, and has been used quite extensively recently, especially in connection with oil as fuel. It is considerably lighter than the Scotch boiler, but, on account of the small amount of water contained, it requires more care in operation. The Scotch boiler has nothing to recommend it theoretically, but its reliability keeps it in use, and, like the reciprocating engine, it is likely to be installed in cargo vessels for many years yet.

The fuel used in cargo vessels until quite recently was bituminous coal. Anthracite coal was discarded after a few years of use, as it was found to be more difficult to adapt to the varied requirements of service. Many cargo vessels do not have artificial draft, but quite a number of coal burners are fitted with heated forced draft, introduced by James Howden in 1884. Since the advent of fuel oil, its use on board ship has been extended so that very few vessels of the present day are designed for coal burning, although the greater number of the vessels afloat still burn coal. The tramp and the liner are both dependent on fueling stations. Very few vessels carry enough fuel for a round trip, and some of the routes are so long that fuel must be taken on at an intermediate station. The United States has about 21 commercial fueling stations at which oil can be obtained, in addition to its home ports. England has numerous coaling stations scattered over the world, but fuel oil is not obtainable except at a comparatively few ports, so that tramp steamers cannot use oil with satisfaction. At first, steam was used to atomize the oil, but that method was found unsatisfactory on account of the waste of fresh water involved, and at present the oil is heated to vaporizing temperature and sprayed mechanically. Heated forced draft is used to burn the sprayed oil, in most cases, and very satisfactory economy is obtained .

Under ordinary conditions the United States cannot build and operate vessels as cheaply as some other nations. To overcome this difference, at present probably about 50 percent, a subsidy would accomplish the purpose, but a subsidy is liable to abuse and has not as yet been recognized as proper by the nation at large. Discriminating duties would accomplish the purpose in part but would help only on vessels importing dutiable articles. Discriminatory tonnage dues would supplement the discriminating duties and would apply to all vessels entering or leaving our ports. Tonnage dues are the nearest equivalent to a protective tariff and could be regulated to a nicety to enable our country to have such a merchant marine as our independence requires, without placing any more burden on any section of our people than has been imposed by the tariff.

The Load Line

Ships are built to stay at sea in stormy weather, and their structure must be strong enough to withstand wind and wave. In the days of the wooden ship, the effect of storms was shown first in the working of the seams, and pumping had to be resorted to regularly to keep down the leaks. In steel ships, the strength of the bottom of the vessel is usually greater than that of the deck, and the riveted seams do not leak so easily, so that except in old vessels a defect of strength was indicated by the posting of the vessel as missing. The stresses in a vessel are greatly increased if the vessel is overloaded, but the effect of overloading is not felt except in a storm. It was some time before this fact was properly appreciated, and a limit to the loading was found to be necessary for the safety of the vessel.

In the United States, there is no legal enactment to prevent overloading, although a committee has been appointed by the Secretary of Commerce to formulate recommendations. A British committee has recently proposed a modification of their freeboard tables basing the loading on an absolute criterion of strength, so that the stronger a vessel the deeper she will be allowed to load. With proper precautions as regards the tightness of hatches and the safety of movement of the crew, this would seem logical. It is hoped that our Government will afford a similar measure of protection to the humble cargo vessel. In the matter of loading, the stresses increase more rapidly as the draft increases, and even a foot of overloading is likely to strain the structure in a storm, and if persisted in to cause the loss of the vessel.

Under ordinary conditions the United States cannot build and operate vessels as cheaply as some other nations. But we can afford to carry our own commerce, just as we could afford to do our own manufacturing. Our independence requires that we shall do our own carrying, and we must not fail to arrange for so doing.

How did we build up our manufactures? We did not buy other nation's manufactures just because they were cheaper than ours, but we put on a tariff that enabled us to compete with foreign goods and to build up our own industries. We must do the equivalent with ships. How? A subsidy would accomplish the purpose with us, as it has with other nations. But a subsidy is liable to abuse, and has not as yet been recognized as proper by the nation at large. Discriminating duties would accomplish the purpose in part, but would help only on vessels importing dutiable articles. Discriminatory tonnage dues would supplement the discriminating duties, and would apply to all vessels entering or leaving our ports. Tonnage dues are the nearest equivalent to the protective tariff, and could be regulated to a nicety to enable this country of ours to have such a merchant marine as our independence requires, without placing any more burden on any section of our people than the tariff did, and could be removed in whole or in part if our cargo vessels, like our manufactures, ever reach the stage of development when no protection is needed, or when all the rest of the world has the same scale of living as ourselves.

The difference in cost of operation is so great, averaging at present probably fifty percent more than our competitors', that to balance the difference in freight rates required to offset the extra cost of operation the amount of discrimination in duties, and the difference in tonnage dues, will have to be quite great for awhile at least. The money which reverts to the Treasury on account of the increased tonnage dues on foreign ships will have to be paid out in some form of subsidy, also, as the vessels engaged in long distance trading and making few entries in a year will need as much assistance as the vessel making many round trips in the same time. The foreign vessel will not have to increase its freight rate appreciably on account of the increased dues, so that the American vessel will not be able to recoup itself for the increased cost of operation on the long voyage by an appreciable increase in the freight rate; and this increased cost must be met by some form of subsidy. The details can be worked out, however, without much trouble, if the American merchant marine is recognized as a national problem and treated as a matter affecting the welfare of every citizen, as it should be treated.

The Effort to Stamp Out Commercial Bribery

BY WALDON FAWCETT

Two mighty forces are at work in the United States to put an end to the orgy of "graft" in connection with the repair and the outfitting of ships that has been for, lo, these many years a reproach to all concerned. That tangible results from this crusade have already been made manifest, particularly at the Gulf and South Atlantic ports, is not the least gratifying feature of the situation. Shipowners who "pay the bills" have, therefore, reason to cherish the hope that they are, at last, to be relieved from a most irritating form of extortion.

OF the two influences that are co-operating, as it were, to purge the ship supply trade of its unholy practices, the most potent is that governmental institution, the Federal Trade Commission. The Trade Commission is sometimes referred to in the public press as "the supreme court of business." In reality it is a business policeman as well as a business mentor. Charged with the administration of the Clayton Act and the Federal Trade Commission Act, this censorial body at Washington undertakes to strike at "unfair trading" in any form, wherever it raises its head. "Complaints," or summons to defend suspicious practices, are served upon individuals and corporations who appear to be transgressing the code of ethical competition, and unless a cited concern can justify its course the complaint is likely to be followed by an order of the Commission to "cease and desist."

During its comparatively brief career the Federal Trade Commission has uncovered in the business world certain practices which, instead of being individual transgressions, constitute evils or unwarranted indulgences so widespread that it has appeared necessary to inaugurate wholesale drives to clear the commercial atmosphere. Most flagrant of the sores revealed is that of "commercial bribery" or "graft" forms of selling and contracting. Commercial bribery appears in various guises, but commonly it consists in the payment of cash commissions, the gift of cash bonuses, the bestowal of valuable presents or the furnishing of costly entertainment to buyers, employees, subordinates and others who are in a position to dictate where purchases shall be made or at least are enabled to recommend in what quarter trade shall be placed.

QUESTIONNAIRES ISSUED

Setting out to scotch commercial bribery wherever found, the Federal Trade Commission had not proceeded far ere it discovered that the ship outfitting and repair field harbored not only the most flagrant examples of persistent and habitual graft, but the most widespread existence of the evil. It was solely, therefore, because here was the greatest need for reform, and not through any prejudice or unworthy motive, that the Trade Commission has concentrated upon the cleansing of the ship supply and repair business. Some sixty ship chandlery, repair and supply firms have already received black marks from the business umpire; and the end is not yet, unless there is widespread voluntary reform.

Two rather prominent firms are, it should be noted, resisting the efforts of the Trade Commission to raise the standards of ship outfitting and maintenance. So much so, that they have "carried up" to a United States Circuit Court of Appeals (as they are privileged to do under the law) the question of the right of the trade body to call a halt on the bribery of vessel masters, engineers and others who exercise the right of specification or purchase. This effort to stay the hand of the Federal reformer has not served, however, to retard the campaign except in the jurisdiction of the Fourth Circuit, where the issue of the authority of the Commission has been thrown into court.

GRAFT, A CUSTOM OF LONG STANDING

The only defense possible to the maritime bribers consists in the dual apology that the giving of "graft" represents a custom of long standing in the industry and that it is justified by the conditions as regards the remuneration of ship officers, etc. The Federal Trade Commission considers the first no excuse at all. It believes that the second is no extenuating circumstance in so far as the American merchant marine is concerned. There is evidence to show that certain classes of foreign shipowners, who pay or have paid in the past comparatively low wages to their masters, engineers, stewards, etc., have winked at the acceptance by these employees of gifts

and allowances from repair and supply concerns—"extras" that, in effect, went to make up for the deficiencies of regular pay. In the estimation of the U. S. Government investigators this excuse, if acceptable anywhere, does not apply to officers and employees in the American merchant marine who, in all cases, receive outright from the owners pay that is commensurate with their services.

What, more than all else, however, has spurred the Federal Trade Commission to action in behalf of cleaner conditions is the appalling evidence that has been unearthed as to the proportions of this evil. It is doubtful if any steamship operator or executive of a shipping corporation, however well informed, has any conception of the extent of this thinly veiled scandal. In the summons served by the Federal Trade Commission upon maritime bribers it has usually been cited that the offending concern was guilty of giving bribes in the form of a commission of 5 percent upon purchases. But that figure of 5 percent was used simply because there is; in certain circles, a pleasant fiction to the effect that 5 percent is the universal, standard perquisite of the men who make purchases for vessels. Accordingly the defendants have usually been willing to admit that they pay 5 percent. And, for the purposes of the Commission a bribe of 5 percent is as effective a basis for action as a bribe of any other proportions.

Five Percent a Minimum

That 5 percent is a minimum in bonus giving, rather than an average, was, however, the discovery of the Trade Commission's investigators who, incident to the proceedings thus far undertaken, have made examinations of the books of about 225 ship chandlery, outfitting and repair concerns located on the Atlantic and Gulf coasts. It was found that the giving of commissions of 20 or 25 percent is frequent; that commissions of 30 percent are not unusual; and isolated instances were found where commissions of 100 percent were actually paid in ship supply transactions. That the average is well above the 5 percent, that some interests would have shipowners believe is the maximum, is illustrated by the evidence obtained by the Trade Commission against a ship chandlery concern in New Orleans, engaged in selling steward's supplies, deck, engine and cabin supplies. It was found in this instance that the valuable gifts, cash gratuities and entertainments given by the seller cost, in the course of a year, in excess of $24,000. In other words the "graft" in this instance represents approximately 8 percent of the firm's entire volume of business, which averages $300,000 per year.

Deficiencies in Quality and Quantity

The eyes of the Trade Commissioners have likewise been opened to the appalling cost of this commercial bribery to the ship operators and the men who pay the bills. Ship outfitters have repeatedly told the Commission that buyers for ships have shown comparatively little interest in the quality of merchandise furnished and absolutely no regard for the prices paid so long as they had assurance that their demands for a "rake-off" would be met. Obviously, though, the addition to the cost of selling must be taken care of by the ultimate consumer and the Trade Commission has found that this fraudulent margin has been passed on to the shipping interest that pays the bills through such expedients as "fake" invoices, short weight, overcharges, short measure, and every other form of addition or subtraction that might be made to serve the purpose.

Even less appreciated, perhaps, by practical shipping men than the extent of the grafting operations and the means of covering the tracks, is the moral effect of this system of selling. The Federal Trade Commission has stumbled upon a scandal that can scarce be credited. The undermining of the morals of men who are constantly receiving or giving bribes is logical and is alone sufficient to condemn the practice, but there is another and darker side to the picture. The Trade Commission has found that whereas a majority of the vessel masters who accept "remembrances" want theirs, as one claimant put it, "in cold cash"; there is a considerable proportion who, upon arrival in port, bluntly put it up to the ship outfitter that they be wined and dined and "shown the town." Some of the evidence of what has been demanded and accorded along this line would be likely to startle the most sophisticated ship operator. And the Trade Commission's investigators found that such rounds of "entertainment" not only have a bad effect upon the efficiency of those entertained but are apt to have undesirable reaction upon the morale of the entire ship's company.

Beginning with the war-time episode when the United States Food Administration, on the recommendation of the Federal Trade Commission, put out of business an open-handed ship chandlery concern, with branches in a number of Atlantic Coast ports, the government has been steadily disciplining every ship service interest as to which conclusive evidence of bribery can be obtained. And just here it should be whispered that the bribery is by no means confined to the ship chandlery concerns, that are accounted its most conspicuous exponents. At the end of March, 1921, complaint was entered against a machine works, located at New Orleans, which has been regularly allowing to ship engineers and other officers gratuities amounting to 10 percent of their repair bills. Most surprising to some of our readers will be the revelation that shipping agents are, in some instances, similarly implicated. That is to say the Trade Commission has unmasked shipping agents who, ostensibly representing vessel owners, are in the habit of receiving commissions from both parties to transactions.

Special Legislation Proposed

Effective as has been the work of the Trade Commission with the weapons at hand, it is desired to make it yet more effective and to that end there is an effort in Congress to provide special legislation that will strike specifically at "commercial bribery." The 67th Congress of the United States will have before it, with this objective, two legislative proposals. One will be a bill—a revised edition of a measure that was considered by the Committee of the Judiciary of the United States House of Representatives only a few weeks ago—which undertakes to penalize "commercial bribery" in all lines of business. The other bill will be a special or specific measure designed to prohibit the payment of gratuities to the masters of vessels or other persons for the purpose of inducing or securing contracts for repairing vessels or furnishing vessels with supplies or other necessities.

The movement to secure national legislation that will, in effect, strengthen the hands of the Federal Trade Commission in its reform campaign, is interesting in itself but it is even more interesting as a background for a widespread drive for satisfactory State legislation to this same end. Some fifteen or sixteen States of the Union have on their statute books at the present time laws designed to put an end to graft in ship outfitting and repair operations. Lax enforcement or non-enforcement has served to all but nullify the force of such law, as witness, for example, the spectacle of six prosecutions and one conviction in New York State. Putting all the blame possible on the laxity of the officials whose duty it is to enforce the law, there remains the fact that many of the State statutes are faulty and inadequate. To correct this the States are being urged to enact what is accounted a "model" commercial bribery law. The State of Louisiana has, within the year, adopted this law, and its working in what was once a hotbed of bribery in shipping operations will be watched with interest.

Business Firms Revolting

The opening months of the year 1921, witnessed the advent of a new influence for higher ideals in ship service

practice that seems destined to match the Federal Trade Commission in achievements, albeit the attack is from the opposite angle. This new element is eloquent of a spirit of revolt and reform within the ship outfitting trade. There have been, always, a minority of ship repair and ship supply firms that resented the customs of bribery that obtained. In a few instances the anti-bribery men have defied their competitors and have steadfastly refused to grant "graft" when demanded. Usually, however, such show of independence has been possible only to machine shops, wholesale grocery firms, wholesale hardware houses and other supply concerns, only a portion of whose business has been derived from the ships. The majority of the service concerns that depend wholly upon ship trade have had to bow to what seemed inevitable custom, regardless of how little they relished the idea of paying for favor.

With the Federal Trade Commission resorting to compulsion, however, and seeking to arouse the public conscience to the point where Congress would enact a special law, the worm turned. A group of ship supply firms at New Orleans and Gulf ports got together in inauguration of a movement to have the trade undertake its own housecleaning. These pioneers formed the nucleus of a new organization, the avowed purpose of which is to remove the taint of bribery from the ship service trade. The best augury for the success of this unique and praiseworthy undertaking lies in the fact that its active management is in the hands of Mr. C. E. La Vigne, who was, until recently, an examiner of the Federal Trade Commission and to whose lot, in that capacity, it fell to make the investigation of bribery practices in the ship service field. Knowing in intimate detail all the iniquities of the system, Mr. La Vigne should be qualified to lead a volunteer movement for emancipation.

Protective Organization Formed

Forty-eight representative ship supply and ship service firms in the territory from Norfolk to Galveston were invited to become charter members of the organization which has, as its avowed object, "the protection of steamship owners purchasing supplies and repairs." Every one of the forty-eight accepted. Theoretically or sentimentally this new body would be accounted a trade association but, considering the purpose in view, it was desired to infuse a stronger element of responsibility, and, accordingly, incorporation papers have been taken out under the name American Ship Service Corporation, with offices in Washington, D. C. The scope of the organization will be in no sense sectional. Members have been enrolled in New York and New England and the campaign for membership will be extended, as promptly as may be, to the Pacific Coast and the Great Lakes.

Absolute good faith and sincerity in intent to eliminate commercial bribery and other evils and abuses in the shipping field is claimed for the new institution. Every dealer, outfitter, or repairer who is admitted to the American Ship Service Corporation is required to sign a pledge as follows: "Membership in this corporation carries with it the understanding and pledge that no gratuities, systematically lavish entertainment, so-called commissions, or other thing of value will be given to any person whatsoever, directly or indirectly, to influence the placing of orders in connection with the shipping business." It is promised that disregard of the pledge in any instance will be followed by the summary expulsion of the offending member and publication of the circumstances of the expulsion. The circumstance that the American Ship Service Corporation is not only working for voluntary reformation of the trade, but is likewise most active in the effort to induce Congress to enact an anti-bribery law holds hint that the new organization may have it in mind to aid in disciplining ship service firms that persist in indulging "grafters."

In conclusion it may be said that there is a feeling at the Federal Trade Commission and among conscientious ship service men that conditions in the shipping industry have become such, latterly, that ship operators may do much to prevent graft by the officers on the ships to whom they have to delegate purchasing authority. There are vessel owners and executives of steamship companies who have long been bitterly opposed to the acceptance by masters, engineers, shipping agents, etc., of commissions from supply firms or service concerns and who have endeavored to make contracts that would forestall such exploitation. But during recent years it has been extremely difficult if not impossible to find protection. Officers for ships have been in demand and the ship operator has been in no position to dictate unusual terms. Ship service concerns that desired to play fair have been similarly handicapped. Indeed, one concern lost in one year $170,000 of contract business because it would not bow to the demands of men on the ships who proposed to have their perquisites or take their business elsewhere regardless of the fact that they were supposedly bound by contracts of the owners. Latterly, however, the supply of available ship officers exceeds the demand. Owners and operators are in a position to pick and choose. Hence they have opportunity to make contracts with ship service concerns committed to the no-bribery platform, with confidence that such contracts will be observed.

American Marine Insurance Syndicate "A" Expands Its Organization

IN order to meet the requirements of the United States Shipping Board for the making of periodical condition surveys, heretofore made by the United States Bureau of Survey, Syndicate "A" of the American Marine Insurance Syndicates has found it necessary to extend its organization both on the Atlantic and Pacific coasts. The manager, Mr. Page, who has just returned from the Pacific coast, reports having established offices at both San Francisco and Seattle.

The former port will be the headquarters of the California district, comprising all California ports, and will be in charge of Mr. David O. Young, an experienced marine engineer, well known to all shipping and insurance men of the Pacific coast and particularly to the San Francisco district, where he was the manager for some years of the Hanlon Drydock & Shipbuilding Company.

The Seattle office will be the headquarters of the Northwestern district, comprising Oregon, Washington and British Columbia. Through the co-operation of the Board of Marine Underwriters of San Francisco the Syndicates have named Captain S. B. Gibbs, agent of the San Francisco Board at that port, as agent of Syndicate "A" as well. Captain Gibbs is well and very favorably known to the shipping and underwriting world, having served the San Francisco Board at Seattle for twenty years past.

Mr. Page also reports that it has been found necessary to extend the Syndicate's organization on the Atlantic coast by the establishment of offices at Boston, Norfolk and Savannah.

The Boston office will be temporarily in charge of Mr. J. A. Wilson, detached from the New York office for the purpose.

The Norfolk office, with jurisdiction over Newport News also, will be in charge of Mr. J. T. Christie, an experienced marine engineer and formerly manager of the United States Bureau of Survey at that port.

The headquarters of the South Atlantic district have now been transferred to Savannah and Mr. M. H. Winner, formerly manager at that point of the United States Bureau of Survey, has been put in charge. This district will exercise jurisdiction over all ports from Wilmington, N. C., to Tampa, Florida, inclusive, Pensacola having been added to the jurisdiction of the New Orleans office.

The Importance of Marine Insurance

BY "OLD SCOTCH"

The insurance charge on an operating merchant vessel is one of the heaviest with which shipping men have to contend. It is also one of the most complicated and intricate subjects to understand. Many tomes have been written on the subject by expert underwriters, and the average man interested in shipping, having read the literary effusions of these experts, shakes his head and generally admits being no wiser than he was before. He will, however, agree with me that it is a complicated subject. I am going to admit that my knowledge is about the same as Mr. Average Man's. I have, however, had opportunities of discussing the subject with many of the best underwriters in the business and have formed my own ideas, crude as they may appear to the initiated, so here they are.

THE man or company who risks his money on the safe arrival at a distant port of a structure known as a ship is a gambler of a legitimate type. His methods in fixing the odds for the proposed marine risk are very much akin to those adopted by the shrewd bookmakers, generally of the Hebraic persuasion, who in the end take your money away from you at a horse race. He may, and very often does, lose on particular bets placed on particular ships, but at the end of the year he has won often enough to pay his losses and submit an income tax return showing that he has made a good livelihood during the season. In the course of a number of years he has, in proportion to the shrewdness and intelligence he has applied to his vocation, either gained a competency or gone broke.

Anyone who has indulged in the so-called "sport of kings" knows that the bookies who tempt the money out of your pocket by the alluring odds they display on each race have arrived at their conclusions by no haphazard methods, but from the knowledge born of experience. They must be capable of sizing up the contesting horses, studying their pedigrees, get all the obtainable "dope" of recent performances, investigate the jockeys to learn of their honesty, habits and weaknesses, and very quickly weigh all attending circumstances in order to announce the odds they are willing to risk on each animal in the race. They must be constantly studying everything that is pertinent to the game which they are playing and investigate every rumor they may hear which is at all relevant to the forthcoming race.

How the Odds Are Determined

In marine insurance the gamble is on the particular ship in her contest with the elements in the guise of storm, current and fog, strandings, collisions and fire. To arrive at the odds he will place on the risk the underwriter must carefully study the pedigree of his ship. How old is she? Who built her? What materials were used? Was she carefully designed by competent people? How has she been cared for? What is the latest dope on her condition at the hour of sailing? Is she loaded properly, etc., etc.? In fact, everything pertaining to the construction of the ship must be carefully weighed and constitutes an important element in determining the rate. Bookmakers use "dope sheets" for the horses, and underwriters use the "dope sheets" or classification society publications for the ships.

Past performances are just as important to the ship underwriter as similar dope is to the bookmaker. Careful account is kept of all losses incurred by the particular ship, the particular line operating her, the particular group to which she belongs, and the particular trade in which she is employed. "The record of the past is the best harbinger of the future" is essentially the general principle guiding the fixer of marine insurance rates.

The moral risk is another very important factor, and by this is meant the efficiency of the personnel, both on shore and at sea, operating the craft. The records of the skipper, the first mate and the chief engineer are just as essential to the ship underwriter as is the record of the owner and jockey operating the particular horse in a race to the bookmaker. Even the element of luck enters into the problem. Some operating lines and some skippers have records of being lucky in their undertakings, others are proverbially hoodoos and bad luck seems to attend their efforts wherever they go, or is liable to result at any time.

Group insurance, or fleet insurance, as it is more properly termed, of assuming a cover for the entire fleet of a particular company for a year at a time is sometimes materially affected by the general reputation of the operators, and in one instance I have heard of by the particular reputation for efficiency of a marine superintendent. This particular official probably did not know it, or otherwise he might have struck for more salary, but a certain American line of steamships was recently given a preference of one-half of one percent on a fleet insurance for a year because the new marine superintendent which they had employed was considered by the underwriters as a particularly able man in the conduct of his functions in operating the ships.

The Personal Equation

The personal equation is one of great importance to underwriters, for even a good ship commanded by an incompetent skipper or the machinery in charge of a careless engineer makes a bad risk for the underwriter. The converse is also true, so that underwriters have a right to know something about the men who are in charge of the ship on which they stake their money. The simple fact that an officer is licensed by the Government is no guarantee that he is the man whom the underwriters are willing to rely upon to have responsible charge of property at sea on which they take a risk.

The shipping community around New York has recently been much interested in some circulars issued by a prominent American steamship company giving reasons why their ships cannot be operated during the present period of depression. By a simple statement of all actual costs to them of all charges except office salaries and expenses, depreciation, interest and other capital charges, it was demonstrated that in the operation of one of their ships to the River Plate at going freight rates they would lose $16,192 on a round trip. Of the items of expense listed the sum of $9,032 was chargeable to insurance for a period covering one round trip only, or 120 days. This, too, was based on a value of only $60 per deadweight ton, whereas the ship in question was built only two years ago, and probably represents an actual capital charge to the owners of not less than $200 per ton. The entire wage charge for this ship for the period of 120 days was $18,760. Had the vessel been insured for her actual value, this item alone would have been far in excess of the total cost of wages of officers and crew. These figures are quoted simply to give an idea of the great importance of insurance to our merchant marine.

Up to 1918 over two-thirds of all insurance in our merchant ships was placed in foreign markets. We thus were

practically at the mercy of our competitors, and this fact acted as a club on our entire foreign trade. Foreseeing the absolute necessity of our creating a market in this country whereby the greater part of our insurance could be kept in our own hands, the leading American underwriters have banded together for co-operative assistance. They have received the sympathetic support of the Federal government in every way possible, and an earnest effort is now being made to pass uniform insurance laws in the several states whereby American companies will have at least an even chance with their robust and experienced foreign competitors. They have been taxed without regard to the profits they made, and foreign companies have been able, in many instances, by devious ways to avoid certain local taxes in this country which the American companies have been compelled to pay.

American Marine Insurance Strongly Supported

The American companies are co-operating by means of what are termed American Marine Insurance Syndicates A, B and C. Syndicate "A" is purely an inspection and salvage association, to which the United States Shipping Board has contributed one million dollars to be used as capital, with the inevitable string on it, however, that it must be paid back to the Government by January 1, 1924, after deducting all legitimate charges incurred in accordance with the agreement entered into by the syndicate. Out of this syndicate will gradually come what is known as the United States Salvage Association, to be conducted along the general plan of the well-known London Salvage Association. In fact, this new association has already been chartered and will be conducted on a non-profit basis in all parts of the world for the benefit of genuine American underwriters. By this means all claims for losses, surveys and necessary repairs will be in strictly American hands, and should result in a considerable curtailment of the losses to which American companies might otherwise be subjected.

Syndicate "B" has now been functioning very satisfactorily for over six months. Its object is to insure all American steamships owned by the Government, and the unpaid portion of such ships as may have been sold by the Government. The facilities of the various American companies comprising this syndicate are such that no less than $2,000,000 may be placed upon any single ship.

Syndicate "C," composed largely of American companies but having some admitted foreign companies, will place insurance on any American ship and has facilities of $2,500,000 on any single American ship.

Generally speaking, the rates granted by these American syndicates are slightly in excess of the prevailing foreign rates, but as the overhead is gradually reduced and the "dope" of experience is accumulated it is expected that in the near future American rates will be as low as any.

Aside from the great national advantages accruing to our foreign trade in the control of the bulk of our marine insurance on both hulls and cargoes, the fact must not be overlooked that several hundreds of millions of dollars paid in premiums, and heretofore annually sent abroad to enrich the coffers of our competitors, will be kept within our own borders.

Bearing these facts in mind, we must all take off our hats to the American underwriters and wish them all success in their real competition with the experienced and financially strong rivals across the waters. Their success will be a most important element in the future success of our merchant marine activities. A well-known American writer very ably summarized this subject by stating:

"Marine insurance bears to commerce the relation of bodyguard rather than merely servile attendant . . . Of the active forces which influence, control or forbid the employment of shipping, none has greater effect than the marine insurance power."

Notes on the Motorship Zoppot

THE German motorship *Zoppot,* which was built by Fried. Krupp, A. G. Germaniawerft, Kiel, Germany, and launched January, 1914, has just undergone minor repairs at the Robins Dry Dock & Repair Company, Brooklyn, N. Y.

This vessel, which has completed seven voyages across the Atlantic without a single stop, has been chartered by the Standard Oil Company of New Jersey. Her principal dimensions are as follows:

Length	525 feet
Beam	66 feet 3 inches
Depth	41 feet 3 inches
Draft	27 feet 9 inches
Gross registered tonnage	9,600 tons
Net registered tonnage	5,700 tons
Displacement	22,000 tons
Cargo carried	14,200 tons
Bunker oil	800 tons

The *Zoppot* is a twin screw vessel propelled by two 4,400 indicated horsepower Krupp-Germania Diesel engines of the 6 cylinder, 2 cycle, single acting type. The engines are directly connected to the propeller shafting, which revolves at the rate of 106 revolutions per minute.

Fuel Consumption

The fuel oil consumption on a round trip between Baton Rouge to Hamburg and return, a distance of 10,600 miles, was 600 tons of 2,205 pounds to the ton. The actual time consumed on this trip was 43 days and an average speed of 10.36 knots was maintained.

The lubricating oil consumption is 30 gallons per day of 24 hours. The gravity system is used and the same lubricating oil having a viscosity of 5.1 is used for both cylinders and bearings. After passing through the engine bearings, cylinders, etc., it is collected in the bedplate and drained to a cell in the double bottom, whence it is pumped through filters to the gravity tanks.

Most of the auxiliaries are driven by steam which is furnished by two donkey boilers. The fuel oil consumption under the boilers at sea is about 2½ tons per day and in port when loading or unloading at full capacity, about 9 tons.

Diesel Electric Drive to be Installed on Ocean-Going Freighter

THE first ocean-going freighter in the United States to be equipped for Diesel oil engine electric drive will result from contracts recently signed between the Todd Shipyards Corporation and the American Mediterranean Steamship Company calling for the conversion of the motorship *Fordonian,* a 2,200-ton vessel, for which the General Electric Company, will furnish the electrical apparatus.

The *Fordonian* is a single screw freighter 257 feet long, 42-foot beam and 26-foot draft, with a deadweight tonnage of 2,200 tons. Her new equipment, which will be installed at the Tebo Yacht Basin of the Todd Shipyards Corporation, will consist of twin Ansaldo San Giorgio two cycle, four cylinder Diesel engines direct connected to two 240 kilowatt, 250 volt, 200 revolutions per minute compound wound direct current generators. The generators will furnish power to a double armature, pedestal mounted, 850 brake horsepower, 120 revolutions per minute motor, which will be directly coupled to the propeller shaft.

The electric auxiliaries furnished by the General Electric Company will consist of one 6 kilowatt volt motor generator set for lighting, one motor-driven blower for ventilating the propeller motor, and three pump motors. These include a 5 horsepower motor driving a 5 by 8-inch vertical triplex single acting fuel oil pump and a 10-horsepower motor driving a 6 by 8-inch vertical Rumsey single acting fire pump.

Motorships Not Being Laid Up

While the Shipping Depression Lays Up Large Number of Steamers, All Motorships Continue in Profitable Operation

BY OUR SPECIAL LONDON CORRESPONDENT

PROBABLY nothing has struck the imagination of British shipowners more than the fact that while large numbers of steamers are now being laid up, all motorships continue on their ordinary trading routes, apparently at considerable profit to the owners in spite of the slump in freights. One of the best examples for the economy of the motorship, which incidentally was not lost on British shipowners, was the recent inaugural voyage of the Johnson Line motorship *Buenos Aires* from Vancouver through the Panama Canal to London, carrying a cargo of Canadian wheat. This ship which is one of a fleet of nine or ten internal combustion engined vessels owned by the same firm, and which has a deadweight capacity of 9,300 tons, is able to carry this cargo on a fuel consumption of 10½ tons per day at a speed of eleven knots, whereas the corresponding steamer would consume about 50 tons of coal.

The service is only an economic proposition for a motorship, since the steamer would have to pay too much for its fuel in order to make a profit on the voyage. The arrival of the *Buenos Aires* and the economy indicated were very well heralded in England, with the result that even more attention has been paid recently to the possibilities of the motorship than before. What is particularly significant from the technical standpoint is that the *Buenos Aires* is a standard ship in every detail and is one of perhaps a dozen similar craft now in service, fitted as she is with Burmeister and Wain machinery of 3,100 indicated horsepower. This policy of standardization on the part of different owners and builders is certainly one of the most extraordinary features of motorship development and it is now possible to find motorships owned and built by British firms which are sister ships to other craft owned and built by Scandinavians. The latest vessel for the Johnson Line, which at the time of writing is on her maiden voyage, is also a sister vessel to the *Buenos Aires*. This is the *Canada*, which was completed in Gothenburg at the beginning of March.

Repair Facilities on Motorships

In all of these standard motorships, one of the features which catches the eye of the engineer on an inspection of the engine room is the excellent arrangements which are provided for carrying out all necessary repairs to the ship. Owners of motorships have found it is usually rather difficult to effect any repair work at many overseas ports and in any case it is often extremely expensive and badly done. They therefore consider it a profitable undertaking to install a somewhat elaborate workshop in the engine room, this being all the more advisable in view of the large amount of space which is available. In the average Scandinavian built motorship of the *Canada* type there is a moderate sized lathe, an excellent drilling machine, a grinding machine and a shaping machine all driven by belting from a little electric motor.

A New Vickers Engine

Although in almost every case British manufacturers of oil engines are standardizing their motors, nevertheless they are taking the opportunity of benefiting by the experience of the existing engines and making such modifications on the later sets as seem desirable. For instance, Vickers have entirely altered the control gear of their new engines compared with the first two sets which were installed in the motorship *Narragansett*. This alteration is significant and the fact that it is necessary should form a guide to marine oil engine designers in America. In this type of engine, which is a four-cycle motor with the usual Vickers solid injection, there are ahead and astern cams as usual, side by side on the camshaft which have to be moved fore and aft when reversing.

In the original arrangement the admission of compressed air for starting, and the control of the fuel valves for speed variation, were effected through a handwheel and the servo motor for moving the camshaft after lifting the valve levers in the cam was mounted on the front of the engine. The servo motor was put into operation by means of a hand lever and it was found that this combination of levers and wheels rendered the process of reversing somewhat arduous. The speed

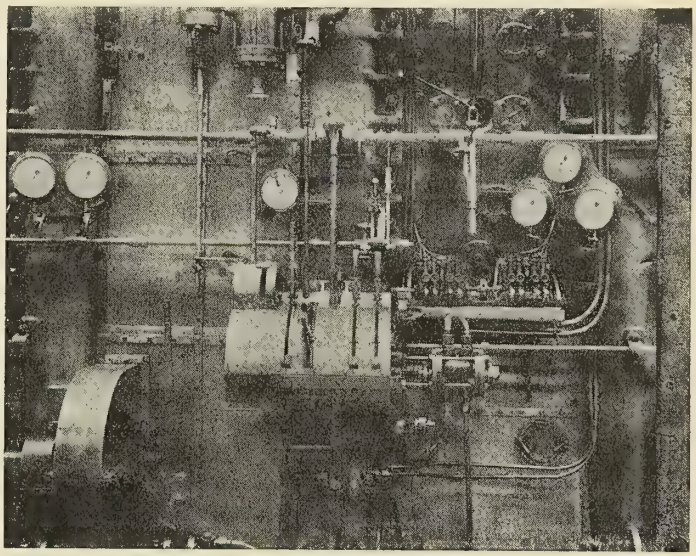


Fig. 1.—Control Station of 1,250-Brake Horsepower Vickers Engine

control is therefore effected by another lever corresponding to the reversing lever and the servo motor is removed from the front of the engine and placed at the top. The arrangement of the present control is clearly seen in Fig. 1 with the four levers; the one on the extreme right is for reversing while that on the extreme left is for starting, and the one adjacent to it for control of the speed by varying the lift of the fuel valves. The fourth lever is not normally in operation but is only used when the servo motor is out of action and the gear must be operated by hand. It will thus be seen that in maneuvering three levers have to be moved, the air starting, the fuel control and the reversing lever. It is rather surprising that the air starting and fuel control levers have not been combined, as they are in the Burmeister and Wain engines, which would then reduce the control virtually to two levers instead of three. Nevertheless the speed of reversing in the new Vickers engine is certainly remarkably good.

Many New Motorships

A series of extremely interesting launches has been effected during the past month or two. Included among the latest craft is the passenger motor liner *Magvana*, now rapidly approaching completion on the Clyde. It will be remembered she is equipped with a couple of the new type of 2,330 indicated horsepower North British Diesel engines and is for

the British India Steam Navigation Company, being designed to carry about 10,000 tons of cargo in addition to passengers. Another ship recently put into the water is the 12,000 ton motor cargo vessel *Somersetshire* for the Bibby Line, a duplicate of the *Dorsetshire,* which since her completion has proved very successful.

A third craft of unusual interest is the *Malia* for T. and J. Brocklebank, also for the Eastern service, in which are being installed two of the new Camellaird Fullagar opposed piston oil engines. It is remarkable what a general belief there is in the possibilities of this new type of engine even among builders of competitive designs and it is perhaps significant that John Brown and Company, of Clydebank, is now building its first 2,500 brake horsepower set of this type. The Cunard Company is watching the developing with considerable interest and in view of its close connection with John Brown and Company, it would not be surprising if the Cunard Company ordered a fairly large boat fitted with Camellaird Fullagar engines in the near future.

It is a curious fact that the Camellaird Fullagar engine designers will have nothing to do with solid injection and retain the usual type of air compressor, although Doxfords, in their new engine in which the opposed piston principle is utilized, are employing solid injection at 9,000 pounds per square inch. The tests on the first 3,000 horsepower Doxford engine have been carried out over a prolonged period and apparently have proved all the manufacturers desired. The fuel consumption works out at about 0.43 pound per brake horsepower hour and the engine will operate satisfactorily on heavy Mexican oil, although of course this fact cannot be finally determined until the vessel in which the engine is being installed has been in operation for some months.

A great deal hinges upon this matter since shipowners are now asking shipbuilders for oil engines that will burn fuel oil as satisfactorily as Diesel oil and builders of Diesel motors are therefore paying a great deal of attention to the problem. It will no doubt be difficult of solution in the case of four cycle engines with their exhaust valves liable to be easily corroded with the heavier fuel, but with two cycle engines both of the opposed piston and single piston type there should be no insuperable difficulties.

Turbine Reduction Gears Versus Electric Propulsion for Ships*

BY ESKIL BERG†

THE question of whether electric or geared propulsion should be used depends entirely upon the type and operating conditions of the vessel. The Navy Department, after years of comparative study and having actual operating data on electrically propelled vessels available, has decided to equip all the larger Navy vessels with electric drive. In this type of ship, electric drive has a decided advantage as economical cruising speed (which is so important for this type) can be obtained, the machinery can be located in the most convenient place furthest removed from disturbances from gun fire or torpedoes, plurality of generating units can be used so that damage to one or more parts will not disable the vessel, and maneuvering can be accomplished more quickly and accurately, etc.

Geared turbine drive has an advantage in fast destroyers and light cruisers. In this type of vessel, the power is generally large and the propeller speed very high—factors which make ideal gear conditions. Geared turbines can here be built very much lighter than electric drive and, as the weight of propelling machinery in this type of vessel is of utmost importance, electric drive being heavier cannot be considered.

In merchant ships each individual case must be studied, and here the question of service, economy, reliability, weight and cost must be taken into consideration.

For fast passenger liners electric drive has an advantage. The transmission efficiency can be made practically equal to a conservatively proportioned double reduction gearing. It has, also, the advantage that the more efficient turbine can be built.

If two generating units are used, one unit will propel the vessel at about three-quarters speed with only slight sacrifice of economy. Noise, so objectionable in passenger vessels, is practically eliminated with electric drive.

In moderate power twin screw ships of about 6,000 to 8,000 horsepower electric drive has a decided advantage both in economy, weight and price if one turbo-generating unit is used to drive both propellers. In case this unit or any of its auxiliaries should become disabled, a simple arrangement can easily be made by which the ship could be run at low speed from the auxiliary generating unit which normally drives the electrically driven auxiliaries.

On the other hand, if two generating units are used, the equipment becomes slightly less efficient, the weight and cost also go up considerably, and the comparison then becomes similar to a 3,000 horsepower single screw freighter.

In the case of slow speed single screw freighters of 2,500 to 3,000 horsepower, the geared turbine is somewhat lighter. The actual transmission efficiency of the gears is also better. However, when the losses of the reversing turbine, power taken by the oiling system, packing losses, as well as leakage of steam due to larger clearances, are taken into consideration, the transmission efficiency is practically equal—if anything in favor of electric drive. If, however, the motor is located aft, doing away with long shafting with its expensive bearings, supports and shaft alleys, the electric drive is the lightest, cheapest and most economical, as well as the most reliable method to use. With the main auxiliaries driven electrically, the ship can by very simple arrangement be run home by power supplied from these auxiliary units should the main propelling machinery or its auxiliaries become disabled.

In freighters of 1,500 horsepower or less, geared turbines are lighter and cheaper. As the power is small, a gear can be designed which is less affected by sudden load variation or disalinement caused by springing of the hull or inaccurate workmanship.

The following is a list of electric propelling machinery now being built by the General Electric Company:

For the Navy	Horsepower of each	Total Horsepower
Three battleships, *California, Maryland, West Virginia*	32,000	96,000
Two battleships, *Iowa, Massachusetts*	60,000	120,000
Four battle cruisers, *Constitution, United States, Saratoga, Lexington*	180,000	720,000
Total		936,000
For Merchant Marine		
Eleven 3,000 horsepower freighters similar to *Eclipse*		33,000
Four 2,600 horsepower Coast Guard cutters, synchronous motor		10,400
One 3,000 horsepower United Fruit Company		3,000
Total		46,400

SHIPBUILDING RETURNS.—The Bureau of Navigation, Department of Commerce, reports 83 sailing, steam, gas and unrigged vessels of 145,852 gross tons built in the United States and officially numbered during the month of March. Of the total, 8 vessels of 51,029 gross tons were built for the United States Shipping Board.

ITALY PLANS NEW SHIPYARD.—A group of Italian banks has provided 66,000,000 lire for construction of a great trade and industrial port at Vade, in the Province of Liguria. In connection with this, at the mouth of the river Quilliane will be established a shipyard.

* Resumé of paper presented at joint meeting of New York Section of American Institute of Electrical Engineers and Metropolitan Section of American Society of Mechanical Engineers, New York, January 28, 1921.

† General Electric Company, Schenectady, N. Y.

Standardized Diesel Engines—III*

Description of Valve-in-Head Method of Scavenging for Two-Cycle Type Engine

BY H. R. SETZ

FIG. 15 shows a two cycle cylinder head and valve gear ready for immediate substitution in the framing of the four cycle engine shown in Figs. 2, 3, 7 and 8. The lower centering flange now becomes a water cooled exhaust belt and therefore performs a double service. The upper centering flange is identical with that used on the four cycle engine, as is the cylinder liner casting. Owing to the enlarged machined diameter provided near the lower end of the four cycle liner, all that is required to adapt it to the two cycle is the milling of the ports.

The cylinder head, of course, changes. It still consists in its elements of three flat disks joined together by the various cylindrical surfaces running perpendicular to all three and forming stud bosses and the valve cage pockets. The middle one of the three disks is the water deflector already described in connection with the four cycle head. A new feature, however, is the absence of any circumferential wall for closing off the interior of the head. This construction, which affords an extraordinary opportunity for good foundry work, is made possible because inlet air only—no exhaust—need be accommodated and because the cooling water is kept below the deflector diaphragm. Only at the center is the cooling water permitted to circulate upward in an annular space surrounding the fuel valve cage sleeve and to discharge through an opening in the top face. Ample area for guiding the scavenging air to the interior of the head is furnished by a light volute-shaped casting flanged to the air manifold and slipped over the outer cylinder head contour. Since the air is therefore merely guided between the roof of the cylinder head and the diaphragm which separates it from the cooling water, it encounters no appreciable resistances or velocity changes until it actually enters the valves. The valve cages are not placed in pockets, nor does their air supply come to them through passages. This particular cylinder head design therefore possesses all those features which make for a casting free from initial casting strains, a certain freedom to expand and contract and ample strength. The well directed uniform flow of the cooling medium around the four valve cage seats towards the center will be of even greater benefit here than in the four cycle head; it must be remembered that the period of cooling between consecutive heat impulses is only half as long in a two cycle engine as in the four cycle type and that the reduction in effective heat transmitting surface due to the openings for the scavenging valves is therefore always somewhat of a detriment in engines of this type.

Practically the entire four cycle valve gear can be used for this machine with the exception of the exhaust valves, which are replaced by two inlet valves combined with the top portion of the exhaust valve cages. Different gears must be used for the camshaft drive, while the camshaft itself, housings, fuel pumps with bearing brackets, eccentrics, push rods and valve cages are the same. The oscillating cam rods for the operation of the outboard valves, acting with their double cam on one moving and one fixed roller, make possible easy clearance adjustments as already pointed out. The rollers for the inboard valve spindles turn on an overhung gudgeon pin pressed into the forked operating lever. To adjust clearances here it

* Copyright, 1921, by H. R. Setz.

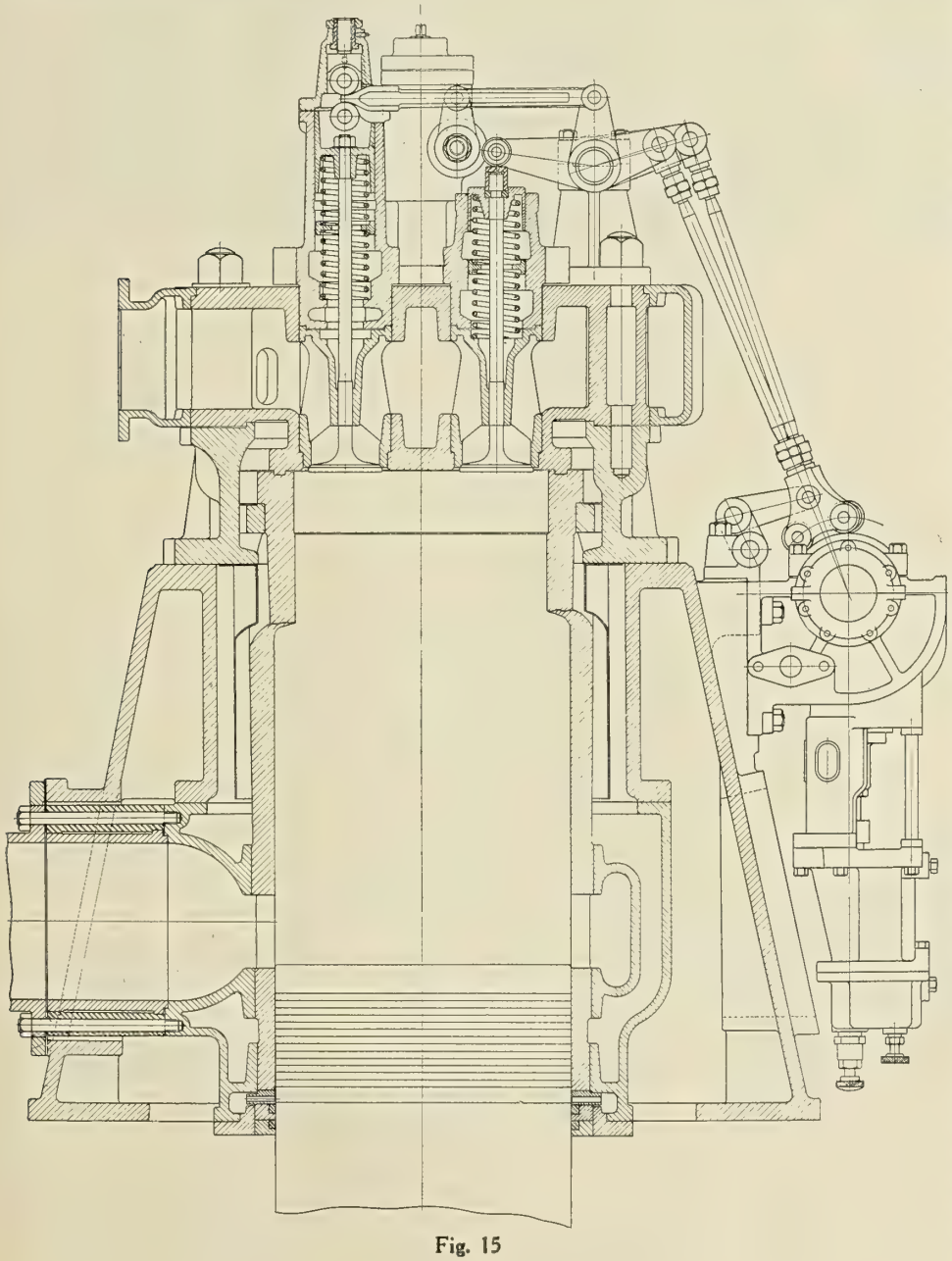


Fig. 15

is necessary merely to strip the roller off sideways, to raise the hardened tappet cap and to change the shims underneath it. The short push rods made possible by the favorable location of the camshaft, together with the light and compact rocker arm, result in a valve gear as well adapted for the particular operating conditions to be met here as is at all possible. Its ready accessibility furthermore facilitates the adjustments which engines of this type demand rather frequently.

Early two cycle engines in capacities of 1,000 horsepower and over were practically all of the valve-in-head scavenging type. In proper recognition of the importance of large scavenging valve areas, two, three and most generally four valves were used by different designers. None of these arrangements has produced results which are in every respect comparable with those of four cycle engines of similar cylinder size. Under severe operating conditions, particularly where the load fluctuates over a wide range, cylinder heads containing scavenging valves developed cracks after comparatively short operating periods. This was particularly pronounced on marine engines where extreme temperature fluctuations occur during maneuvering owing to the introduction into the hot cylinders of cold starting air. Special materials, such as manganese bronze and steel, have only deferred but not eliminated this cylinder head trouble and greatly increased the cost of such engines. But even if by careful design in regard to favorable material distribution and cooling as shown in Fig. 15, and through the elimination of air starting in the engine cylinder by the method previously described, cylinder head breakage can be prevented or greatly reduced, there still remain problems of no small practical consequence which weigh heavily against the valve-in-head principle.

The most tenacious of these is the valve operating mechanism. Since the scavenging valves are to open about 10 percent before and close about 25 percent after the lower dead center, their duration of opening extends over a crank angle of approximately 100 degrees, which at a speed of 125 revolutions per minute corresponds to .133 second. This is less than half the time available for operating these same valves in a four cycle engine and the valve lifts occur twice as often. Considering further that in the two cycle engine all these valves are lifted at the same instant, it can readily be appreciated that the kinematic forces which must here be dealt with are several times larger than in a four cycle engine of the same size and speed. This and the comparatively high frequency at which these forces do occur indicate the seriousness of the valve gear problem. Because of practical limitations, cam surface and pin pressures can hardly be reduced to magnitudes customary on four cycle engines, with a consequent rapid wear on these surfaces which require frequent adjustment. Probably the most serious effect, however, is the excessive wear on the gears driving the vertical and cam shafts. These being usually of helix form, they are extremely susceptible to violent and rapid load impulses and the very best of material and most carefully worked out and tended lubricating system cannot prevent appreciable wear. Adjustments on these gears for wear are extremely delicate to make. As a whole, therefore, the valve gear in its entirety for two cycle valve-in-head scavenging engines is difficult to control from a constructional point of view and delicate to handle under severe operating conditions, particularly in marine service.

For these reasons many other methods of scavenging and entirely new types of engines have been suggested and tried experimentally on a large scale which greatly broadened our perception and positive knowledge of the physical phenomena involved in the scavenging process and the mechanical means appropriate to their satisfactory control. The essential and conclusive facts which have come through this evolutionary stage are, first, that admission of scavenging air can be accomplished entirely satisfactorily by means of ports in the cylinder wall opposite the exhaust ports, and, second, that it is through this method of port scavenging that the enormous possibilities of the two cycle Diesel engine can be fully realized. Remarkable progress has already been made in this direction and the general engine structure previously described here permits of a further notable advance of modern two cycle engine construction.

(To be continued.)

Commerce Passing Through Panama Canal During 1920

THE *Panama Canal Record* gives the following data in regard to the commercial traffic passing through the Canal during 1920. It says: "Of the 11,236,119 tons of cargo shipped through the Canal in the year 1920, 6,124,403 tons, or over one-half the total, were shipped in whole cargoes, the respective vessels containing only the one commodity at time of transit. Of the whole cargoes, 2,236,745 tons were from Atlantic to Pacific and 3,887,658 tons from Pacific to Atlantic. The shipments of commodities aggregating over 100,000 tons in shipload lots were as follows:

ATLANTIC TO PACIFIC

Commodity.	Tons.
Fuel oil	828,223
Coal and coke	651,844
Refined oils	355,494
Steel and iron	157,405

PACIFIC TO ATLANTIC

Nitrate	1,995,906
Flour	487,614
Cold storage products	347,479
Wheat	318,944
Lumber	205,172
Sugar	127,995

Nationalities of Vessels

Of the 2,814 commercial vessels using the Canal during 1920, the leading nationalities were as follows: The United States ships numbered 1,281, or 45.5 percent of the total; the British ships numbered 867, or 30.8 percent of the total; the Japanese, 122, or 5 percent; Norwegian, 111, or 3.9 percent. The numbers and tonnage of the ships, by nationalities, are summarized in this table:

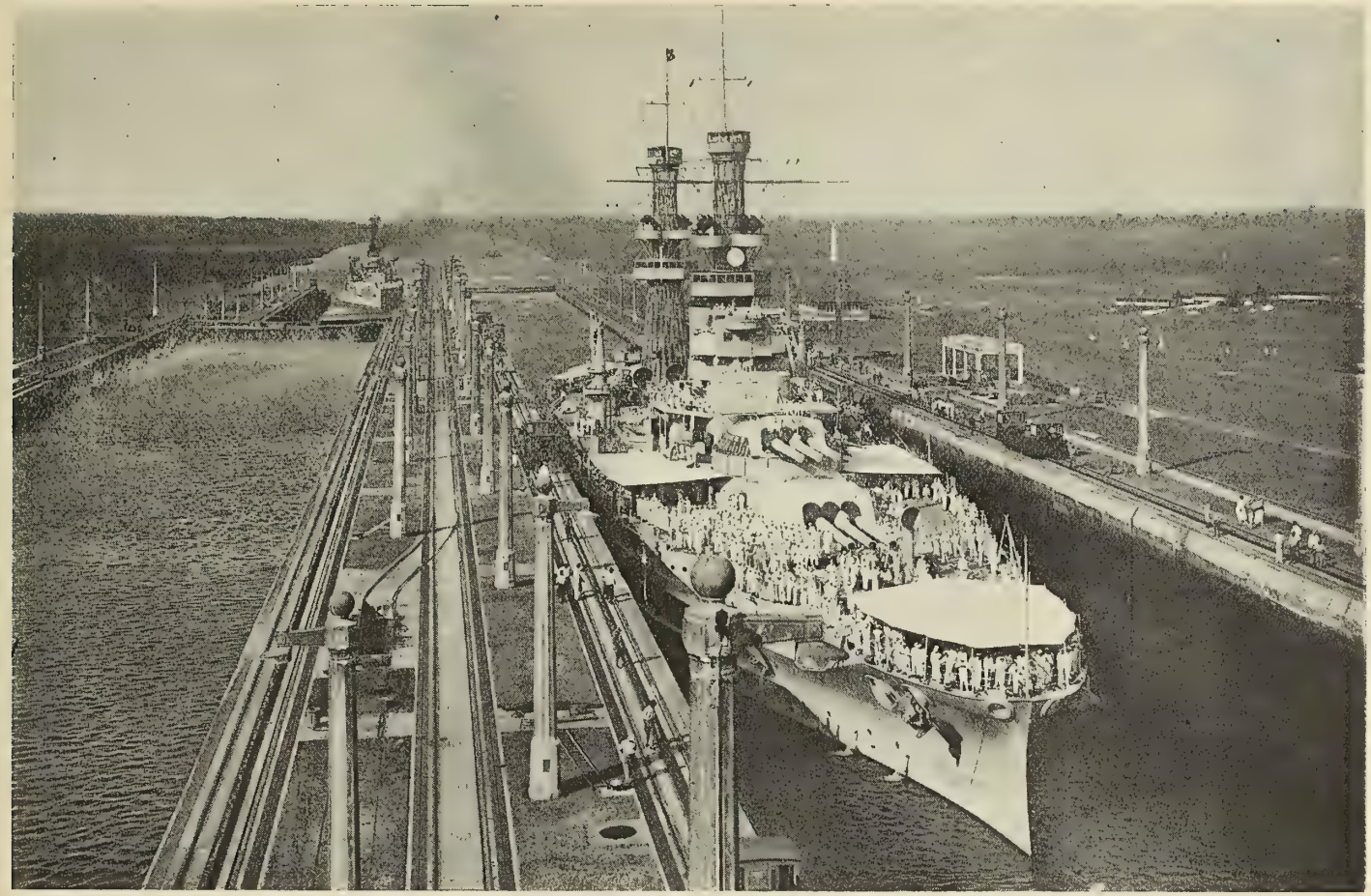
COMMERCIAL TRAFFIC THROUGH THE PANAMA CANAL FOR THE CALENDAR YEAR 1920, BY NATIONALITY OF VESSELS

Registry.	No. of ships.	Tonnage. U. S. equivalent	Panama Canal net.	Registered gross.	Registered net.	Tolls.	Tons of cargo.*
Belgian	2	6,303	8,092	10,144	6,188	$7,886.25	12,700
Brazilian	1	5,436	6,294	6,692	4,126	6,795.00	8,916
British	867	2,707,826	3,333,676	4,242,357	2,649,963	3,357,357.55	3,305,681
Chilean	78	139,008	212,202	271,927	157,861	170,518.90	88,464
Chinese	4	10,564	12,008	16,[illegible]5	10,624	13,187.10	14,400
Colombian	1	84	85	96	57	105.00	27
Costa Rican	13	2,055	2,201	2,381	1,624	2,392.65	1,641
Cuban	1	578	702	1,050	577	722.50	1,200
Danish	30	92,255	110,432	131,297	84,662	114,035.15	158,110
Dutch	33	121,493	164,361	181,276	115,547	150,715.18	139,258
French	53	139,219	152,690	206,642	135,623	161,527.04	132,149
German	32	87,344	114,727	137,814	84,855	107,004.83	125,455
Italian	31	97,081	120,544	170,370	102,235	121,304.65	89,835
Japanese	122	480,197	545,665	723,476	466,303	583,643.93	764,206
Jugo-Slav	2	3,902	4,508	6,370	4,068	4,877.50	8,325
Mexican	2	2,169	2,638	2,559	1,659	1,899.36	.....
Norwegian	111	366,719	433,389	573,895	356,998	411,422.03	486,889
Panaman	8	1,382	1,370	1,568	1,340	1,489.90	872
Peruvian	72	115,603	187,621	288,515	153,110	143,129.05	119,462
Portuguese	2	8,838	9,002	11,210	7,056	10,802.40	10,775
Russian	1	4,740	5,14[illegible]	7,464	4,779	5,925.00	12,147
Swedish	18	51,743	75,454	78,668	57,918	63,511.25	92,893
Spanish	49	112,108	128,324	171,953	111,78[illegible]	130,615.33	153,467
United States	1,281	3,986,755	4,747,036	6,056,518	3,939,445	4,724,494.66	5,509,247
Totals	2,814	8,543,408	10,378,265	13,300,887	8,45 ,401	$10,295,362.21	11,236,119

*2,240 pounds to ton.

Record Traffic During January, 1921

"All previous records for traffic through the Canal were broken during the month of January, when 279 commercial



U. S. S. *Pennsylvania* in Middle Chamber of Gatun Locks at Panama Canal

and 79 noncommercial vessels transited the Canal. Of the above ships, 197 passed from the Atlantic to the Pacific and 161 from the Pacific to the Atlantic.

"The number of commercial vessels, tonnage, tolls, etc., as compared with previous high records, are as follows:

	January.	Previous high record.	Date.
Number of vessels	279	266	August, 1920.
United States equivalent tonnage	894,689	832,742	September, 1920.
Panama Canal net tonnage	1,094,323	1,027,918	December, 1920.
Registered gross tonnage	1,383,778	1,298,864	December, 1920.
Registered net tonnage	880,362	823,758	December, 1920.
Tolls levied	$1,095,857.46	$1,010,150.63	September, 1920.
Tons of cargo carried	1,177,052	1,076,539	December, 1920.

"Of the 79 noncommercial vessels, 60 were United States Navy ships, which were classified as follows: Battleships 9, cruiser 1, destroyers 19, supply vessels 10, mine sweepers 3, submarine chasers 4, submarines 7, submarine tender 1, repair ship 1, hospital ship 1, Navy tugs 3, Navy launch 1.

"In addition to the above 60 Navy vessels there were 7 vessels under control of the United States Shipping Board passing through the Canal with fuel for the Navy."

Notable Wartime Repair

IN making up a heavy propeller shaft, four bronze sleeves were shrunk on the shaft. It was intended to have the sleeves close enough in series to admit of calking the joints. On cooling, however, it was found that the sleeves lacked approximately half an inch of butting—a distance too great for effective calking. The sleeves at either end of the series were of slightly greater diameter than the two intermediate sleeves, the former being designed to turn in bearings and the latter to serve merely as a protection for the steel shaft where it would otherwise be exposed directly to the corroding influence of salt water in the section between the two bearings.

To have brought the sleeves together by removing and reshrinking them, even if it could have been successfully accomplished, would have involved considerable difficulty and expense; and it seemed more than probable that such an attempt would have resulted in a repetition of the initial failure. For this reason it was decided to experiment with welding. It was not, however, deemed advisable to fill in the spaces by adding metal fused with the blowpipe while the sleeves were frozen to the shaft, as it seemed likely that the weld would pull apart on cooling. The problem, then, became one of applying preheat in a manner that would not result in disalinement of the shaft.

First a special preheating hood was prepared to admit of uniformly heating a single one of the four sleeves. Then one of the sleeves was expanded by preheating the area enclosed

Bronze Bearing and Protecting Sleeves Welded on Propeller Shaft

in the hood, when the preheated section was welded to the cold sleeve next in series. This process was then applied to the succeeding sections serially, in each instance heating a single sleeve and welding it to the cold sleeve adjoining.

Double Reduction Gears for Merchant Ships*

BY R. J. WALKER, C.B.E., AND S. S. COOK, B.A.

At the spring meetings of the Institution of Naval Architects last year a paper was read by Engineer-Commander Tostevin on "Experience and Practice in Mechanical Reduction Gears in Warships." Commander Tostevin in his paper dealt very fully with the development of gearing from its inception and the precautions necessary to ensure the successful running of these gears. The present paper is confined to the application of mechanical gearing to merchant ships, with particular reference to double reduction.

UP to the outbreak of war a total of over 260,000 horsepower of geared turbines for merchant service was built and under construction with single reduction gears. During the war and since the signing of the armistice about 750 ships, representing a total horsepower of over two millions, have been constructed in America alone, fitted with double reduction gearing, and in Great Britain and other countries the number of ships built and under construction is about 220, representing a total of about 1,150,000 horsepower.

In the initial stages of the development and application of double reduction gears in Great Britain certain troubles were experienced. In a few cases excessive wear of the teeth was found to have taken place either just after the full power trial or very early in the life of the vessel. This caused a certain amount of anxiety in the minds of some shipowners and engineers, and the position was somewhat aggravated by the fact that several double reduction gears in American ships had not come up to expectations.

Many theories were advanced as to the probable cause of the troubles referred to, among others the following: Too high a tooth pressure as compared with single reduction; defective material; inferior lubrication; and faulty workmanship in regard to cutting and alinement. As regards the first of these, there is no doubt that there was a very strong impression abroad that the tooth pressures adopted with double reduction gears were too high—that is, compared with single reduction gears. There was, however, no evidence to justify the conclusion that the pressures adopted with double reduction gears were higher than successful practice with single reduction would warrant. When comparing the proportions of gears a common use of the term "pressure per lineal inch of tooth surface" had been made by some engineers. Such a basis of comparison by itself had no real value. The load per inch of face should be judged in its relation to the diameter of the pinion employed.

Generally speaking, with conditions similar in other respects and with gears of the same ratio, the load per inch of face could be made to increase with the diameter of the pinion because of the difference in curvature of tooth surface. The radius of curvature of the surface of the teeth is practically in proportion to the diameter of the pinion. For large pinions above 10 inches diameter the practice of the Parsons Company is to allow the load per inch to increase only as the square root of the diameter. This empirical rule takes into account the width of line of contact on the assumption of a constant limit to the thickness of the effective portion of oil film. It is a more conservative view than has been taken by some makers, who allow the load per inch to increase directly with the diameter of pinion. For pinions less than 10 inches diameter the load is taken proportionately to the diameter of the pinion. The following figures represent the general average practice for service conditions in merchant ships. For pinions less than 10 inches and with the normal depth of tooth, the value of the constant $\frac{P}{d}$ lies between 60 and 75; for pinions above 10 inches diameter the value of the constant $P/\sqrt{d}$ lies between 180 and 220, unless lower values are specially requested.

In view of the troubles which occurred in the initial stages referred to previously, some shipowners had expressed a desire, in connection with new work, for a further margin of safety on past practice until more extended experience in actual service had been obtained.

As the result of further extended experience on service and theoretical investigations there is nothing to show that considerably higher loads could not be adopted than are represented by the above figures. Several vessels with double reduction gearing are now in service giving very satisfactory results. The steamship *Somerset* has been in service for over two years, the steamship *San Florentino* and steamship *San Fernando* over eighteen months, and three of the "N1" class standard ships—the *Danier, Andalusier* and *Aster*—for over twelve months. The loads and load constants for these vessels on service conditions are as follows:

Ship	Second Reduction Pinion Diameter, d	Load P in Pounds per Lineal Inch of Face	$P/\sqrt{d}$
S.S. *Somerset*	22.7	928	195
S.S. *San Florentino* / S.S. *San Fernando*	19.334	932	212.5
S.S. *Danier* / S.S. *Andalusier* / S.S. *Aster*	13.58	880	238

The following particulars respecting double reduction gearing installed in a rolling mill at Calderbank, which has been in constant operation for ten years, may be of interest: Power transmitted, 750 horsepower; revolutions reduced from 2,000 for the turbines to 70 for the main wheel; load per inch of axial face, 1,150 pounds; diameter of pinion, 14.9 inches; and constant $P/\sqrt{d} = 298$.

The only cases of trouble in double reduction gears, with which the authors have been directly associated, arose in connection with two oil-carrying vessels, the *San Florentino* and *San Fernando,* in which the machinery is placed right aft. After the trials of the latter, indications were observed of excessive pressure at definite angular positions around the gear wheel. In these cases a peculiar condition had apparently arisen due to the variation in the propeller resistance as the blades cut through different parts of the wake, and the irregular tooth pressure which this caused was aggravated by the fact that at the full normal working speed the period of the blades passing the sternpost nearly synchronized with the period of the torsional vibration of the propeller and shaft in relation to the gear, thus greatly augmenting the pressure on the main gear wheel at certain positions on the periphery.

The frequency of torsional oscillation was estimated to be about 280 per minute, corresponding in the case of a four-bladed propeller to 70 revolutions per minute. The actual revolutions during the full speed trial were 65 to 67. This

* From a paper read at the sixty-second session of the Institution of Naval Architects, London, Eng., March 17, 1921.

question of synchronism is dealt with more fully later in the paper.

Experiments were taken in hand by Mr. Laing, of the Wallsend Slipway Company, in conjunction with the Parsons Company, in order to investigate the exceptional conditions which had arisen in connection with these two ships. The obvious remedy appeared to be to keep away from this critical period, and in the case of the S.S. *San Florentino* a three-bladed propeller was fitted instead of the existing four-bladed one, and this had the effect of diminishing the frequency of the blades passing the sternpost by about 30 percent. Concurrently new rims were fitted to the secondary gear wheels cut with a deeper tooth, so as to obtain increased tooth surface. It is understood that the gearing in this ship, after running 30,000 miles, is in splendid condition.

In the *San Fernando* temporary measures only were taken to obviate the synchronism to which the authors have alluded, by increasing the pitch of the propeller blades from 18 feet 6 inches to 20 feet 6 inches, and thus slightly reducing the revolutions, the gears installed in this vessel remaining as originally designed. An inspection of the gears after running 50,000 miles showed the teeth to be in excellent condition, no wear whatever having taken place other than the slight pitting or flaking which occurs in many gears in the initial running, and then ceases. This result was achieved with only the slight alteration in the pitch of the four-bladed propeller referred to.

Subsequently to this alteration records were taken on the S.S. *San Fernando* of the variation in torque by means of a Hopkinson-Thring torsion meter with scale boxes movable over an angular range of 150 degrees, readings being taken at intervals of 6 degrees.

These readings are shown in Fig. 1 at a propeller speed of 61.3 revolutions per minute. The figure for the torque has

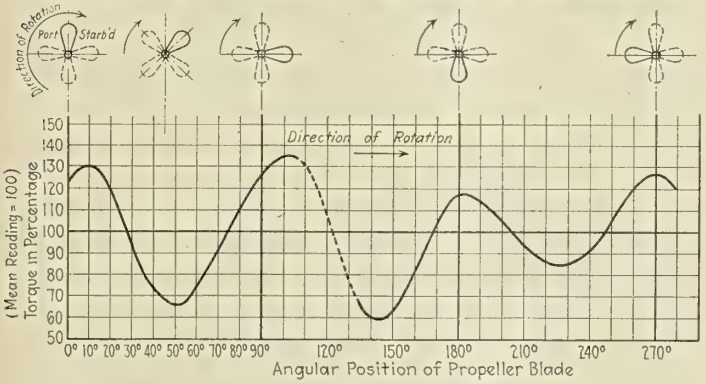


Fig. 1.—Variation of Torque, *San Fernando*

for convenience been reduced to a mean value of 100, and on this basis the maximum value obtained was 133.6 when one of the propeller blades was nearly vertical, and the minimum 67.9 with blades inclined at about 45 degrees. The length of shafting between propeller and gear was 35 feet.

Experiments were also made to determine the speed of the wake at various points of the screw disk by means of a model of the vessel with Pitot tubes attached to its stern. At a speed corresponding to 11 knots of the full-sized ship these experiments showed considerable variation in wake speeds, due apparently to the fulness of the after-end lines usual in this type of vessel. A judicious fining of the lower part of the cross-sections at the after end of the vessel, even at the expense of a probable slight increase in the length or dimensions of the vessel, would be advantageous and probably have the effect of considerably reducing the variation in wake, with a consequent improvement in propulsive efficiency. The values found for the ratio of $\frac{V - V_1}{V}$ (where V = speed of ship and V_1 = speed of wake water through screws) at various positions in the plane of the propeller are given in Fig. 2. The figures given on the diagram are not corrected for any difference in relative frictional resistance between the model and the full-sized ship.

Good materials and effective lubrication of the teeth are important. The authors are of the opinion, however, that the most important factors in the successful running of gears

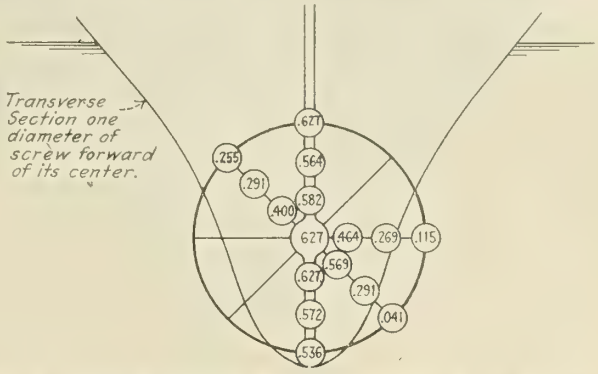


Fig. 2.—Wake Distribution Obtained on Model of *San Fernando*

are accuracy in manufacture, which includes in particular the *cutting of the teeth* and *correct alinement*. These two points cannot be too strongly emphasized.

It is desirable that the machines for cutting gears should be periodically overhauled. It is also necessary that the truth of the machine should be checked at frequent intervals, especially after cutting heavy gear wheels.

The view has been frequently expressed that there is some vital difference between double reduction and single reduction gearing. The authors and their colleagues, after the investigations which have been made, see no reasons why double reduction gearing should be less satisfactory than single reduction. They can speak on this subject with greater confidence now that there are several double reduction sets in actual service and running very satisfactorily. In view, however, of the above impression, it is necessary carefully to analyse the details in which they differ.

Criticisms at one time or another have been devoted to the following features:

(1) The energy of the turbines and gearing.
(2) Flexibility of the shaft.
(3) The end movement of the secondary pinions.

As regards the first of these, the rotary energy of the turbine rotor is large because of its high angular and surface velocity. Whether the reduction be double or single, the energy of the turbine is, as a rule, greatly in excess of that of the gear wheels and propellers.

Supposing that there is a certain variation in the torque of the shaft, how does this affect the load upon the teeth? It is clear that the inertia of the gear wheel will absorb some of the shock. In the absence of elasticity in the rotor and pinion shafts and in the teeth themselves, the extent to which it does so is a matter of simple arithmetic. The shock has to be entirely absorbed by the increase or decrease of the combined rotary energy of turbines and gearing. The proportion of the shock which comes upon the teeth is in the ratio of the energy of the turbine rotor to the total of turbines and gearing. In consequence of the predominance of the energy of the turbine rotor, this is a large percentage in either case—in the neighborhood of 90 percent—and there can be very little difference between single and double reduction in this respect.

A main propeller shaft of about 15 inches diameter does not at first glance appear to be a very flexible object. This is, however, a question of degree. The twist of the shaft at full load over so short a length as 2 or 3 feet is now commonly

used to measure the horsepower transmitted. Over a considerable length the twist is quite appreciable. Thus for a shaft of 15 inches, transmitting, say, 3,000 horsepower at 100 revolutions per minute, the angular twist is about 2 degrees for every 100 feet of length. This is equivalent to a displacement of 2 inches at the periphery of a 9-foot propeller or of a gear wheel of that diameter. A flexibility of this order is necessary to absorb the periodic variation of propeller resistance of a four-bladed propeller. To provide this flexibility in any other way is almost impracticable. It cannot be provided in the intermediate shaft, for to do so would demand that the angular twist of that shaft at full load should be some 10 or 12 degrees, viz., the 2 degrees mentioned above multiplied by the ratio of the diameters of

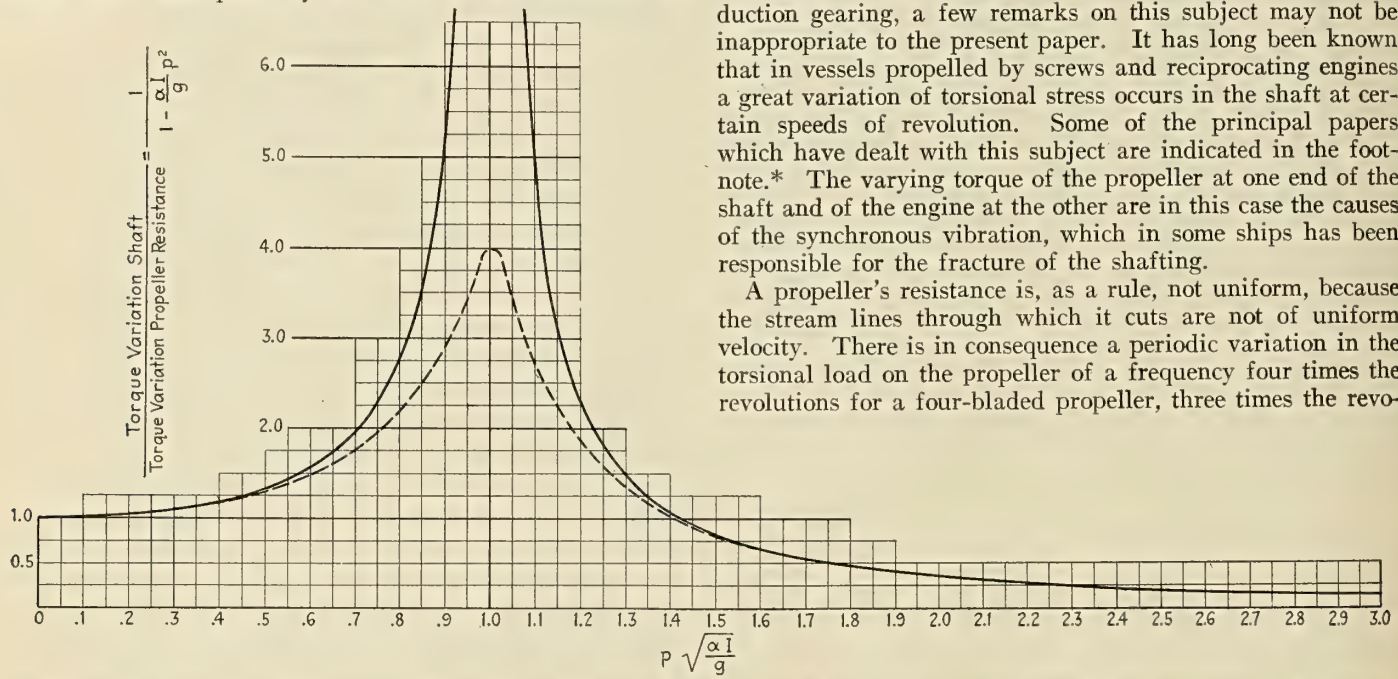


Fig. 3.—Curve Showing Torque Variation at Gear Wheel End of Propeller Shaft as Affected by Flexibility of Shaft and Inertia of Propeller

secondary wheel and pinion. It will be seen that as regards any variation at the teeth of the gear, the main shaft is by far the most flexible part of the installation. The flexibility of the pinion shaft, along with the structural flexibility of gear case and teeth, may, however, have some value in reducing fluctuations of higher frequency, such as might arise from irregularities in the teeth. If then there is any difference between a single and a double reduction in this respect, it will be to the advantage of the latter.

Another feature has been referred to, viz., the end movement of the secondary shaft. Those who have ever measured the amount of end movement of a pinion will agree that a movement of 1/100 inch would be a very conspicuous amount. Let it be supposed, however, that the movement is double this—that is to say, 1/100 inch in each direction from the mean position, and synchronizing with the revolutions of the wheel. From this amplitude and period it is simple enough to calculate the maximum acceleration. At 100 revolutions per minute it will be 1/350th of the gravity acceleration, so that the force on the teeth in an endwise direction arising from this motion would be equal to 1/350th of the total weight of the secondary shaft, or, in other words, a force of a few pounds only. In comparison with the total end force on the teeth this is insignificant.

Another point which received careful investigation at the time of the introduction of double reduction gearing was the equilibrium of the intermediate shaft. The resultant force on the primary teeth is not equal in amount to, nor in general in the same direction as, that on the secondary teeth. Where these forces are in an upward direction there will be a certain speed at which the intermediate shaft will rise in its bearings, and unless both ends rise together it would go out of alinement. In most cases this difficulty is overcome by placing the primary wheels between the halves of the secondary pinion teeth, so that the loads on the teeth are symetrically disposed along the intermediate shaft. In other cases it is desirable to arrange matters so that the shaft rises at a comparatively low speed, so that at full loads it is firmly pressed against the top side of the bearings and again in alinement. It is necessary to study carefully the direction of the resultant forces on the bearings of this shaft under various loads, so that the oil grooves may be placed correctly.

Although the possibility of the occurrence of torsional vibration of the propeller shaft is not confined to double reduction gearing, a few remarks on this subject may not be inappropriate to the present paper. It has long been known that in vessels propelled by screws and reciprocating engines a great variation of torsional stress occurs in the shaft at certain speeds of revolution. Some of the principal papers which have dealt with this subject are indicated in the footnote.* The varying torque of the propeller at one end of the shaft and of the engine at the other are in this case the causes of the synchronous vibration, which in some ships has been responsible for the fracture of the shafting.

A propeller's resistance is, as a rule, not uniform, because the stream lines through which it cuts are not of uniform velocity. There is in consequence a periodic variation in the torsional load on the propeller of a frequency four times the revolutions for a four-bladed propeller, three times the revolutions for a three-bladed propeller, and so on. The shaft, however, is flexible, as we have seen, and the changes in the torque transmitted through the shaft will be somewhat different from the changes in the propeller resistance. At one end of this flexible shaft is a propeller possessing a certain amount of inertia. At the other end is a gear wheel in contact with other gear wheels attached to the turbine rotor. On account of the high revolutions of the turbine the rotary energy of the turbine and gear wheels is many times greater than that of the propeller, and for the sake of simplicity and clearness of conception this end may be considered as having infinite inertia or a constant angular velocity. There is then a flexible shaft, one end fixed or moving with constant angular velocity, and to the other end attached a mass of known inertia. The theory of the motion of such a system is now pretty well known. In the absence of damping it can vibrate freely as a torsional pendulum with a frequency which is determined by the flexibility of the shaft and the moment of inertia of the propeller. When the variation of the propeller resistance synchronizes with this natural frequency a state of

* Frahm, "Recent Investigations Concerning Dynamical Action in Shafting of Marine Engines, with Special Reference to Synchronous Torsional Vibration," Journal American Society of Naval Engineers, August, 1902; Journal German Society of Engineers, 1902.
Gumbel, "Torsional Vibrations of Shafts," Transactions Institution of Naval Architects, 1902, 1912.
Lanchester, "Engine Balancing," Proceedings of Institution of Automobile Engineers, March, 1914.
Jansen and Richardson, "Investigation of Shafting Failures and Engine Vibration on Vessels of the *Louisiana* Class," Journal of the American Society of Naval Engineers, February, 1917.
J. Frith and E. H. Lamb, "The Breaking of Shafts in Direct Coupled Units, Due to Oscillations Set Up at Critical Speeds," Journal of Institute of Electrical Engineers, March, 1902.

forced oscillation is set up, and the torque in the shaft, and consequently the pressure on the gear wheel teeth, may be subject to very considerable fluctuations.

It is not sufficient, however, to calculate this natural frequency and avoid synchronism between it and the propeller impulses, because large periodic forces may be induced in the shaft for a considerable range of speed on either side of synchronism. It is necessary to have a complete determination of the forces set up in the flexible shaft under a periodic variation of the propeller resistance of any frequency. With this done it is then possible to see to what degree the shock on the propeller is carried through to the gear wheel teeth, or, in other words, to what extent it is smoothed out by the elasticity of the shaft and under what conditions it is aggravated by this elasticity.

Assume, then, first of all, the simple system consisting of a shaft fixed at one end and carrying at the other end a disk of known inertia, beyond which is applied a periodic impulse, $P \sin p\,t$, of frequency $p/2\pi$. In such a system, if a be the flexibility of the shaft measured by the ratio $\frac{\text{twist}}{\text{torque}}$ and I the moment of inertia of the disk, or propeller, at its end, the varying torque in the shaft will be expressed by the formula

$$\frac{P \sin p\,t}{1 - \frac{aI}{g} p^2}.$$

If there were no damping effect, this would become infinitely great when $p = \sqrt{\frac{g}{aI}}$, and this value of p corresponds to the frequency of natural vibration. Thus when $p = \sqrt{\frac{g}{aI}}$ there is a synchronism between the applied impulse and the natural vibration, and only damping prevents the vibrations from attaining amplitudes sufficient to break the shaft. One method of investigating the subject, therefore, is to estimate this critical speed and compare it with the frequency of the applied disturbance. The better way, however, is to use the above formula to obtain an exact estimate of the variation at any speed. This formula will show the extent to which the impulses are felt at the end of the flexible shaft for all values of their period on either side of the synchronous speed.

Now, the actual case of a propeller shaft driven by gearing (if we neglect the weight of the shaft and regard the energy of rotation of the turbines and gearing as being so large that this end may be considered to have an invariable speed) is precisely similar to such a system.

$P \sin p\,t$ representing the variation in propeller resistance above and below its normal value, occurring $\frac{p}{2\pi}$ times every second, the variation in the value of the turning moment of the forces on the gear wheel teeth above and below its normal value will be given by

$$\frac{P \sin p\,t}{1 - \frac{aI}{g} p^2},$$

where

a = flexibility of the shaft = $\frac{\text{twist}}{\text{torque}}$,

I = moment of inertia of the propeller.*

The diagram (Fig. 3) shows the changing value of the maximum torque variation as the flexibility of the shaft is increased. With a perfectly stiff shaft the variation in the propeller resistance is transmitted along the shaft undiminished. As the flexibility is increased the effect in the shaft first increases until the point of synchronism is reached and then diminishes. When the flexibility has increased to double that which gives synchronism the torque variation has again fallen to a value equal to that of the propeller resistance. For further increase of flexibility it continues to diminsh until for large values it practically disappears, leaving the torque at the end of the shaft practically undisturbed by the impulses on the propeller blades.

In the neighborhood of synchronism the variation is considerably damped owing to the resistance of the water to change of propeller speed, so that the real curve would be somewhat as shown by the dotted line.

With the engines amidships there is, as a rule, no difficulty in obtaining sufficient flexibility to give a value of $\frac{aI}{g} p^2$ in the neighborhood of 7 or 8, in which case, as will be seen from the diagram, the variation of torque is almost annulled. But where the engines are placed aft with a shaft only between 30 and 40 feet in length, it will usually be found that the value of $\frac{aI}{g} p^2$ is less than 1.0, and it may be necessary to increase the diameter of the shaft to avoid too large a variation factor.

* This can be easily proved (without recourse to differential equations) by denoting the torque in the shaft by $L \sin p\,t$. The angular displacement of the propeller end of the shaft will be $-\,a\,L \sin p\,t$ on account of its flexibility. The angular acceleration of the propeller will therefore be $+\,p^2\,a\,L \sin p\,t$, and the torque required to produce it $+\,p^2 \frac{aI}{g} L \sin p\,t$. The torque of the shaft must therefore be greater by this amount than the torque of propeller resistance, which is therefore equal to $\left(1 - \frac{aI}{g} p^2\right) L \sin p\,t$, or $\left(1 - \frac{aI}{g} p^2\right)$ times the torque in the shaft, having the same frequency and phase. The frequency is $\frac{p}{2\pi}$ (since when t is increased by $\frac{2\pi}{p}$ the value of $\sin p\,t$ is repeated). The synchronous frequency is therefore $\frac{I}{2\pi}\sqrt{\frac{g}{aI}}$.

Shipbuilding in Porto Rico

BY A. H. JOHNSEN

A 1,000-TON steel coal barge, 152 feet long overall, 124 feet long on the waterline, 36 feet beam, and 11 feet load draft, is under construction near San Juan, P. R., for the Porto Rico Coal Company. The barge is not only capable of carrying 1,000 tons of coal, but provision for 400 tons of water will be made later, if desired.

On each side running lengthwise is a sloping bulkhead, and at the bottom a bucket type of conveyor will carry the coal to a tower located at the end of the barge. This tower reaches 68 feet above the deck and is so arranged that both sides of a vessel may be bunkered simultaneously.

The coaling machine, of the elevator type, is a combination between the Link-Belt and the De Mayo types, and is so arranged that it will deliver 250 to 300 tons of coal an hour.

The building of this barge in Porto Rico is quite a problem, as all the steel, plant equipment, lumber, etc., was brought from the United States. The vessel is being built under Lloyd's rules and specifications. Snare and Triest Company, of New York, has the contract at a cost of about $132,000.

Problem of the Hull and Its Screw Propeller–II*

Derivation of Design Curves for the Screw Propeller—Computation for Basic Condition of Propeller—Problems Illustrating Analysis of Propeller

BY REAR-ADMIRAL C. W. DYSON, U. S. N.

THE vessels which are selected to be used must all have propellers having the same radial distribution of projected area but of several different projected area ratios. The vessels selected by the author were of types 1 and 3, but of different block coefficients, and ranged from a *S.B.C.* of .375 to .60, from a destroyer to a dreadnought, while the projected area ratios, measured outside of a circle of two-tenths the diameters of the propellers, varied from .6 to .328.

The blades were oval with the widest part of the projection at two-thirds the radius from the center, while the blade peripheries outside the widest part, measured on the arc, were well rounded.

The ships at trial were just out of dry dock, thoroughly cleaned and painted, and were run over the measured mile in good weather. Each point of the trial curves was obtained by at least three runs at the same or approximately the same revolutions, two runs in one direction and one in the opposite. The highest point of the performance curves was obtained by five runs.

The propellers of all the ships were of manganese bronze machined to a true pitch and to the desired blade sections, which were the same type for all the propellers and highly polished.

The trials were run by competent and experienced men, while the data were taken and computed by trained observers and engineers. There was every reason to believe that what were collected were as reliable as could ever be obtained under actual ship conditions.

Derivation of Design Curves

Taking the derived data and from these obtaining valves of pounds indicated thrust per square inch of disk area (*I.T.*D) of the propeller and corresponding pounds propulsive thrust per square inch of projected area ($P.T._p$), a series of curves were plotted with *I.T.*D as abscissas and $P.T._p$ as ordinates and intermediate curves for intermediate projected area ratios were interpolated.

Curves of corresponding tip speeds in feet per minute (*T.S.*) and of propulsive coefficient (*P.C.*) were also laid down, as were also the curves of apparent slip (*S*).

At one point on each of the established curves of *I.T.*D — $P.T._p$ a decided change in conditions was found to occur, the curve either taking a sudden rapid rise or beginning to fall rapidly.

The values of these points in *I.T.*D, *T.S.*, *P.C.* and *S* were taken and plotted on values of *P.A.* ÷ *D.A.* (projected area ratio) as abscissas and the equations to the curves obtained when possible, that for *I.T.*D being:

$$I.T._D = 28.54\left(\frac{P.A.}{D.A.}\right)^{1.7}$$

while that for *T.S.* is:

$$T.S. = 38.148\left(\frac{P..I.}{D..I.}\right)^{.8365 \,-\, 2\left(\frac{P.A.}{D.A.}\right)}$$

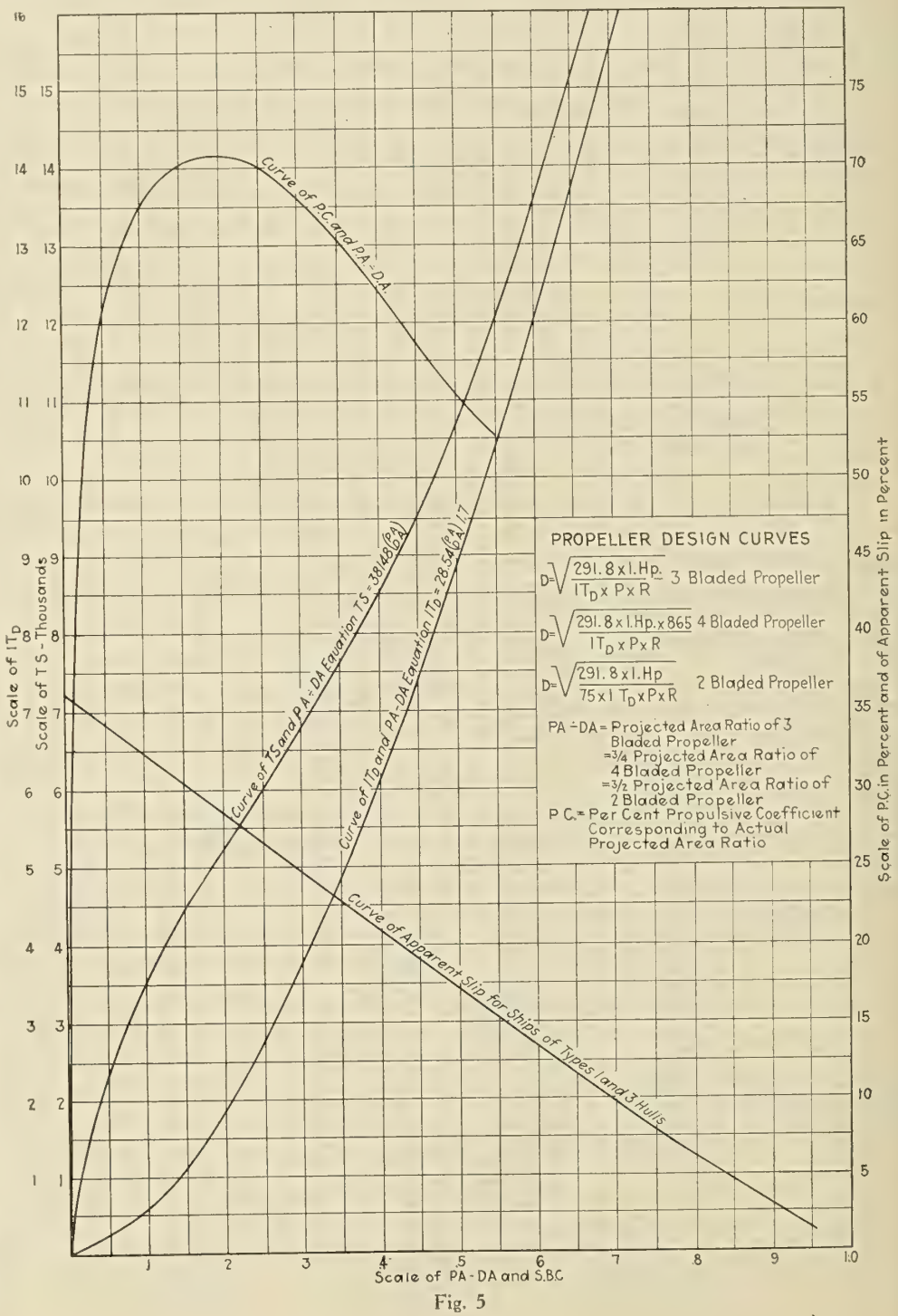

Curve of P.C. and PA÷DA
Curve of TS and PA÷DA Equation TS=38.148(PA)
Curve of ITD and PA÷DA Equation ITD=28.54(PA)1.7
Curve of Apparent Slip for Ships of Types 1 and 3 Hulls
Scale of ITD
Scale of T S - Thousands
Scale of PA - DA and S.B.C.
Scale of P.C. in Percent and of Apparent Slip in Percent
PROPELLER DESIGN CURVES
D=√(291.8 x I.Hp. / ITD x P x R) 3 Bladed Propeller
D=√(291.8 x I.Hp. x 865 / ITD x P x R) 4 Bladed Propeller
D=√(291.8 x I.Hp / 75 x I TD x P x R) 2 Bladed Propeller
PA÷DA = Projected Area Ratio of 3 Bladed Propeller
=¾ Projected Area Ratio of 4 Bladed Propeller
=½ Projected Area Ratio of 2 Bladed Propeller
P C = Per Cent Propulsive Coefficient Corresponding to Actual Projected Area Ratio

Fig. 5

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1920.

Equations to the curves of *P.C.* and of *S* could not be obtained.

These curves are all shown on Fig. 5 and the conditions covered by them are denoted basic conditions and are constant, with the exception of the *S* curve, which, it will be noted, is based on *S.B.C.* as abscissas and not on *P.A.* ÷ *D.A.* In other words, each standard *S.B.C.* has its constant standard basic slip.

This curve of *S* is again shown on Fig. 6, but is there based on values of 2 × length of after body of the ship ÷ the draft, which brings in the final correction for hull form already mentioned.

Correction of *S* for Varying Values of $2L.A.B. \div H$

On Fig. 6 is shown a curved marked Slips for *S.B.C.* on *X* — *W*, Type 1 and 3 Hulls. This curve is in reality the same as the curve of *S* shown on Fig. 5, but in the case of Fig. 6 it is erected on abscissa values of $2L.A.B. \div H$ instead of on *S.B.C.* and the *S.B.C.* values are marked on it at the standard values of $2L.A.B. \div H$ as determined from Fig. 1.

Experience has demonstrated that as the lengths of after bodies of ships increase or decrease from the standard the basic values of *S* decrease or increase, and in decreasing or increasing follow a general law which may be expressed by the following equation:

$$A\ (1 - S)^a = \frac{2L.A.B.}{H},$$

where *A* is the length of after body ÷ *H* at which the basic apparent slip becomes zero, while the exponent *a* depends for its value upon *A*. The lower scale of abscissa is the scale of *A* upon which the curve of the exponent *a* is erected. The curves developed from the equation for coincident values of *A* and *a* are erected on values of $2L.A.B. \div H$ as abscissas, the scale being that given on the upper scale of abscissas, Fig. 6, while the ordinates are values of basic apparent slip *S*.

The curves are direction curves according to which *S* varies as the ratio $2L.A.B. \div H$ varies from standard. Thus, suppose the *S.B.C.* of the vessel be .575. By examination of Fig. 6 it is seen that the curve marked $A = 22.5$ crosses the line of standard *S* at *S.B.C.* = .575 and $2L.A.B. \div H = 16.3$. Now suppose the ratio $2L.A.B. \div H$ for the vessel in question be $17\frac{1}{2}$. The curve $A = 22.5$ is seen to cross the ordinate of $17\frac{1}{2} = 2L.A.B. \div H$ at .113, which is the value of *S* to use in determining the basic condition of the vessel's propellers.

Computation for Basic Condition of Propeller

To illustrate the method of determining the basic condition of a propeller, let an example be taken, as follows:

Suppose the corrected *S.B.C.* of the vessel be .575; the ratio $2L.A.B. \div H$ be 17.5; the propeller blades of standard form and three-bladed.

Let diameter = *D* = 16 feet; pitch = *P* = 18 feet; projected area ratio = *P.A.* ÷ *D.A.* = .34. Then from Fig. 5 we obtain the following data:

1. Tip speed for *P.A.* ÷ *D.A.* = .34 = 7,480 feet, from which, since

$$\text{pitch} \times \text{revolutions} = P \times R = \frac{T.S. \times P}{\pi D},$$

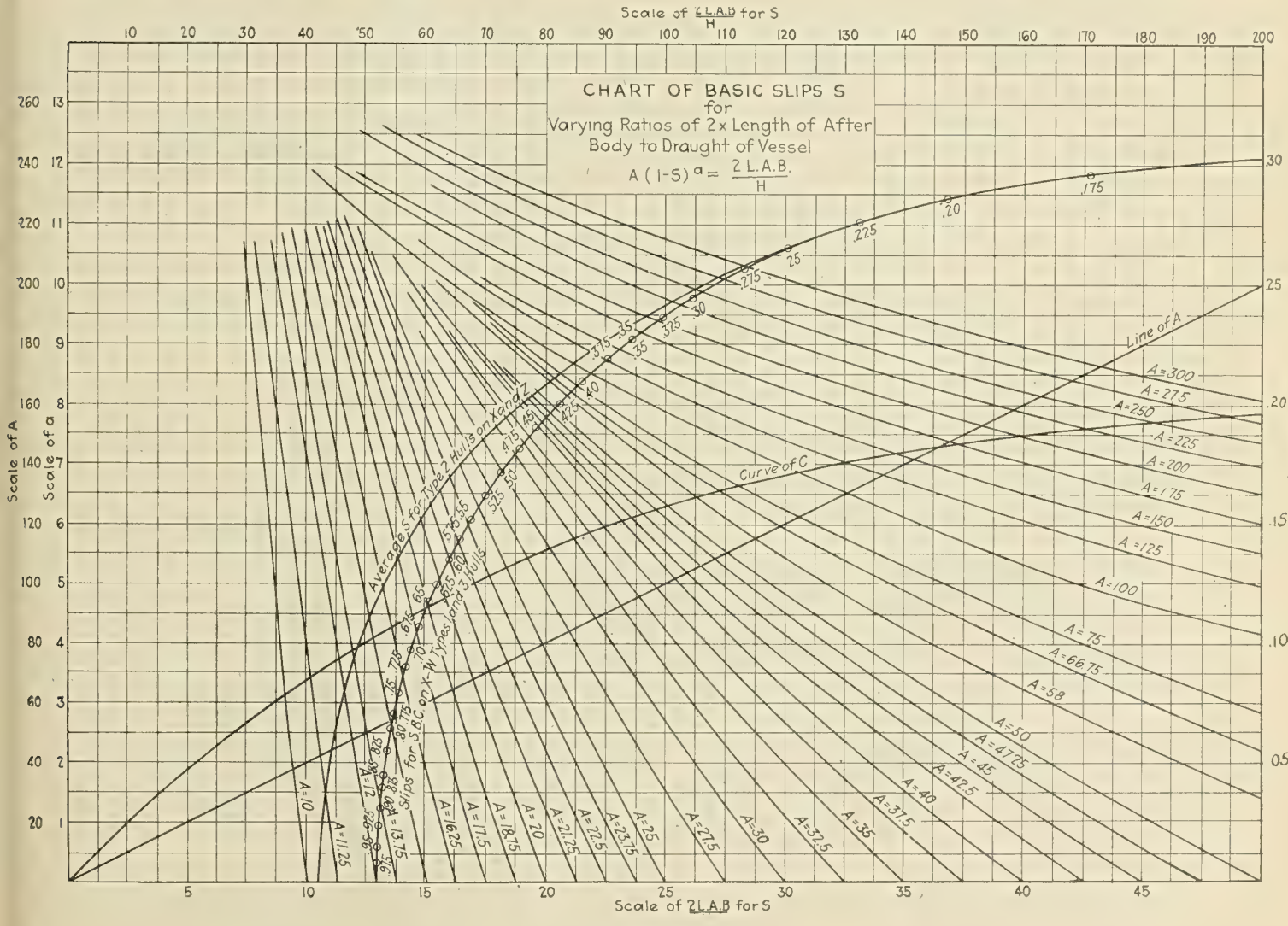

Scale of 2L.A.B / H for S
CHART OF BASIC SLIPS S
for
Varying Ratios of 2 x Length of After Body to Draught of Vessel
A (1-S)^a = 2 L.A.B. / H
Line of A
Curve of C
Average S for Type 2 Hulls on X and W
S.B.C. for X-W Types and 3 Hulls
Slips S.B.C. on X-W Types and 3 Hulls
Scale of A
Scale of a
Scale of S
Scale of 2L.A.B for S

Fig. 6

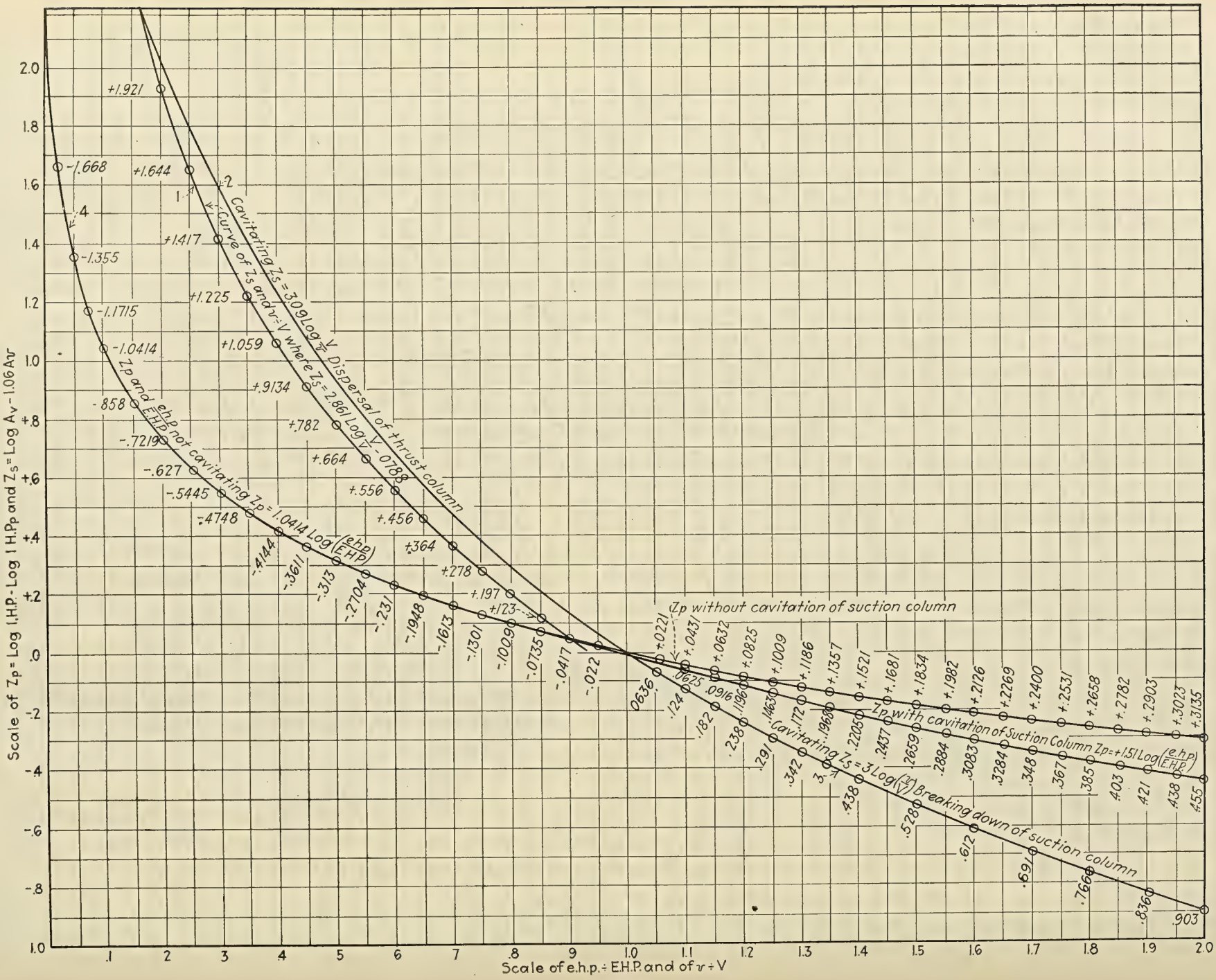

Scale of Zp = Log I.H.P. - Log I H.P and Zs = Log Av - 1.06 Av
Scale of e.h.p. ÷ E.H.P. and of v ÷ V
Cavitating Zs = 3.09 Log v/V Dispersal of thrust column
Curve of Zs and v ÷ V where Zs = 2.861 Log v/V - .0788
Zp and E.H.P. not cavitating Zp = 1.0414 Log (e.h.p./E.H.P.)
Zp without cavitation of suction column
Zp with cavitation of Suction Column Zp = +1.51 Log (e.h.p./E.H.P.)
Cavitating Zs = 3 Log (v/V)
Breaking down of suction column
+1.921
-1.668
+1.644
+1.417
-1.355
+1.225
-1.1715
+1.059
-1.0414
+.9134
-.858
+.782
-.7219
+.664
-.627
+.556
-.5445
+.456
-.4748
+.364
-.4144
+.278
-.3611
+.197
-.313
+.123
-.2704
+.0221
-.231
+.0431
-.1948
+.0632
-.1613
+.0825
-.1301
+.1009
-.1009
+.1186
-.0735
+.1357
-.0417
+.1521
-.022
+.1681
+.1834
+.1982
+.2126
+.2269
+.2400
+.2531
+.2658
+.2782
+.2903
+.3023
+.3135
.0636
.0625
.0916
.124
.1463
.182
.172
.196
.1968
.238
.2205
.291
.2437
.342
.2659
.2884
.3083
.3284
.348
.367
.385
.403
.421
.438
.455
.438
.528
.612
.769
.766
.836
.903

Fig. 7

basic speed $= V = \dfrac{P \times T.S. \times (1 - S)}{\pi D \times 101.33} =$

$$\frac{18 \times 7{,}480 \times .887}{\pi \times 16 \times 101.33} = 23.45 \text{ knots.}$$

2. Indicated thrust per square inch of disk area $= I.T._D = 4.7$ for $P.A. \div D.A. = .34$, then basic indicated horsepower for a three-bladed propeller $=$

$$I.H.P. = \frac{P \times R \times I.T._D \times D^2}{291.8} = \frac{T.S. \times P \times I.T._D \times D}{\pi \times 291.8} =$$

$$\frac{7{,}480 \times 18 \times 4.7 \times 16}{\pi \times 291.8} = 11{,}045,$$

and assuming that the shaft horsepower equals 92 percent of the indicated in well built and adjusted engines, a figure which experience demonstrates to be nearly correct, basic shaft horsepower $= S.H.P. = .92 \times I.H.P. = 11{,}045 \times .92 = 10{,}161.4$.

3. The propulsive coefficient for a projected area ratio of .34 is seen from Fig. 5 to be $P.C. = .667$. Therefore the basic effective horsepower $= E.H.P. = I.H.P. \times P.C. = 11{,}045 \times .667 = 7{,}367$.

VARIATION OF THE ABOVE FOR FOUR BLADES AND FOR TWO BLADES

Suppose the propeller should have four blades with a total projected area ratio $= .453$ or a two-bladed one with a projected area ratio $= .227$, then:

Blades	4	2
Total $P.A. \div D.A.$ =	.453	.227
Total $P.A. \div D.A.$ =	.34	.34

that is, the basic $P.A. \div D.A.$ equals ¾ total for the four blades and equals 3/2 total for the two blades.

The values of $T.S.$ and $I.T._D$ are those pertaining to the basic $P.A. \div D.A.$, while the propulsive coefficients which are dependent upon the total area ratio will be those corresponding to the total projected area ratios.

The formulas for basic indicated horsepower become for four blades:

$$I.H.P. = \frac{T.S. \times P \times I.T._D \times D}{.865 \times \pi \times 291.8} = \frac{7{,}480 \times 18 \times 4.7 \times 16}{\pi \times 252.41} = 12{,}768.$$

For two blades:

$$I.H.P. = \frac{T.S. \times P \times I.T._D \times D \times .75}{\pi \times 291.8} =$$

$$\frac{7{,}480 \times 18 \times 4.7 \times 16}{\pi \times 389.1} = 8{,}283.$$

The basic effective horsepowers now become:

Four blades: $E.H.P. = 12{,}768 \times .568 = 7{,}252.$
Two blades: $E.H.P. = 8{,}283 \times .712 = 5{,}898.$

Should the blades be of other than standard distribution of projected area, other corrections occur which the limits of this paper will not allow of discussion.

CONDITIONS OTHER THAN BASIC (FIG. 7, CURVE 4)

Usually the performance of a vessel and its propeller will be very remote from the basic conditions of the propeller. In such cases it is necessary to have a ready means of converting from basic to actual conditions, and such means, so far as power is concerned, are provided as follows:

Let *e.h.p.* be the effective horsepower required by a given vessel for a speed v, then

$\dfrac{e.h.p.}{E.H.P.}$ = fraction of basic load and $\dfrac{v}{V}$ = fraction of basic speed.

Taking a large number of vessels having hulls of such form and propellers so located that the value of the power augment K will be unity and from the curves of performance of each vessel obtaining the indicated horsepower required to deliver fractional loads with the speeds v at which these fractional loads were required and denoting this $I.H.P.$ by $I.H.P._p$ the equation for $I.H.P._p$ will be:

$$I.H.P._p = I.H.P. \times \left(\frac{v}{V}\right)^w$$

in which the factor $\left(\dfrac{v}{V}\right)^w$ is constant for any given value of $\dfrac{e.h.p.}{E.H.P.}$.

This equation may be expressed thus:

$$\text{Log } I.H.P._p = \log I.H.P. + w \ (\log v - \log V),$$

which, by transposing, becomes:

$$w \ (\log V - \log v) = \log I.H.P. - \log I.H.P._p.$$

Now represent this value $w \ (\log V - \log v)$ by the symbol Z_p, and after establishing several values of it at corresponding load fractions determine the equation to the curve passing through these points and the basic point where $\dfrac{e.h.p.}{E.H.P.}$ and $\dfrac{v}{V}$ both equal unity.

This equation will be:

$$Z_p = 1.0414 - 1.0414 \log \left(\frac{10 \, e.h.p.}{E.H.P.}\right);$$

or, to simplify it,

$$Z_p = 1.0414 \log \left(\frac{E.H.P.}{e.h.p.}\right)$$

for values of $\dfrac{e.h.p.}{E.H.P.}$ less than unity, and

$$Z_p = 1.0414 \log \left(\frac{e.h.p.}{E.H.P.}\right)$$

for values of $\dfrac{e.h.p.}{E.H.P.}$ greater than unity; these values are subtractive from log $I.H.P.$ in the first case and additive in the second, so that for values of

$$\frac{e.h.p.}{E.H.P.} < 1, \quad \log I.H.P._p = \log I.H.P. - Z_p$$

$$\frac{e.h.p.}{E.H.P.} > 1, \quad \log I.H.P._p = \log I.H.P. + Z_p.$$

Should the efficiency of the combined hull and propeller be such that the value of the power augment factor K is greater than unity, then, denoting the total power by $I.H.P._d$,

$$I.H.P._d = K \times I.H.P._p = \frac{K \times I.H.P.}{10^{z_p}},$$

or

$$\text{Log } I.H.P._d = \log I.H.P. + \log K \mp Z_p.$$

These equations neglect all correction for effects of cavitation, which will be discussed further on.

PROBLEMS ILLUSTRATING ANALYSIS OF PROPELLER

In order to illustrate all that has been treated in the foregoing, two problems are here given, the first being the series of vessels used by Commander McEntee in his article on the "Propulsive Efficiency of Single Screw Cargo Ships" which was read before the Society of Naval Architects and Marine Engineers at its 1919 annual meeting.

It must be remembered, however, that in Commander McEntee's vessels the ships were not evenly balanced in their lines, the effect of shifting the middle body aft having its greatest effect on that vessel having the resultant shortest

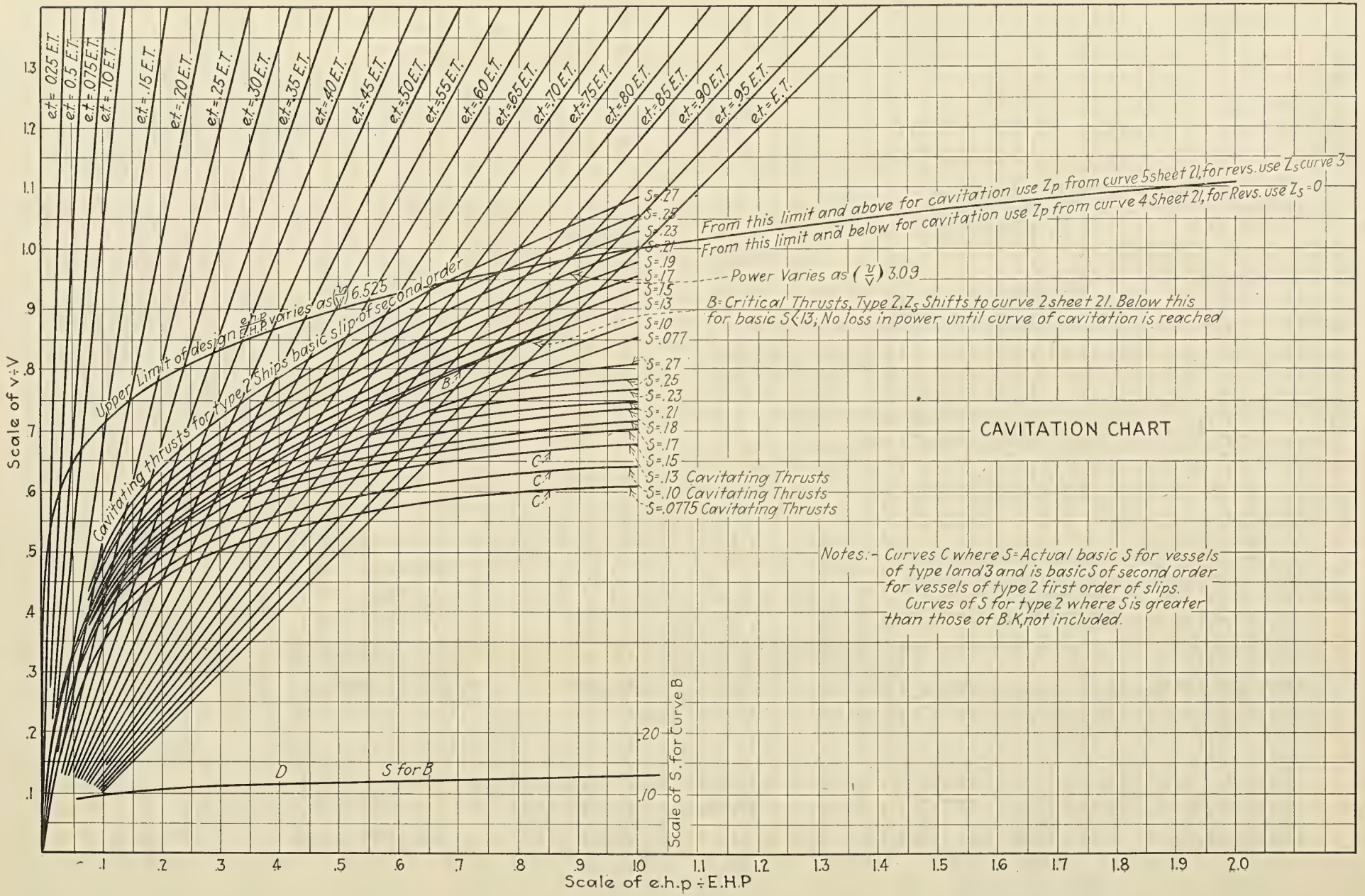

e.t.= .025 E.T.
e.t.= 0.5 E.T.
e.t.= .075 E.T.
e.t.= .10 E.T.
e.t.= .15 E.T.
e.t.= .20 E.T.
e.t.= .25 E.T.
e.t.= .30 E.T.
e.t.= .35 E.T.
e.t.= .40 E.T.
e.t.= .45 E.T.
e.t.= .50 E.T.
e.t.= .55 E.T.
e.t.= .60 E.T.
e.t.= .65 E.T.
e.t.= .70 E.T.
e.t.= .75 E.T.
e.t.= .80 E.T.
e.t.= .85 E.T.
e.t.= .90 E.T.
e.t.= .95 E.T.
e.t.= E.T.
Upper Limit of design e.h.p
Cavitating thrusts for type 2 Ships basic slip of second order
S=.27
S=.25
S=.23
S=.21
S=.19
S=.17
S=.15
S=.13
S=.10
S=.077
From this limit and above for cavitation use Zp from curve 5 sheet 21, for revs. use Zs curve 3
From this limit and below for cavitation use Zp from curve 4 Sheet 21, for Revs. use Zs=0
Power Varies as (v/V) 3.09
B= Critical Thrusts, Type 2, Zs Shifts to curve 2 sheet 21. Below this for basic S<.13; No loss in power until curve of cavitation is reached
CAVITATION CHART
S=.27
S=.25
S=.23
S=.21
S=.18
S=.17
S=.15
S=.13 Cavitating Thrusts
S=.10 Cavitating Thrusts
S=.0775 Cavitating Thrusts
Notes:- Curves C where S=Actual basic S for vessels of type 1 and 3 and is basic S of second order for vessels of type 2 first order of slips.
Curves of S for type 2 where S is greater than those of B.K, not included.
D
S for B
Scale of S. for Curve B
Scale of v÷V
Scale of e.h.p ÷ E.H.P

Fig. 8

PROBLEM 1.—VESSELS OF TYPE 2, SINGLE SCREW

$L.B.P. = 400^{1}$	$\frac{2L..I.B.}{H} =$	$11^{1}.9$	$11^{1}.4$	$10^{1}.88$	$10^{1}.37$	$9^{1}.86$
$B = 57^{1}.3$						
$H = 26^{1}$	Nom. *B.C.*	.7242	.7438	.7634	.7830	.8026
$\frac{B}{L.B.P.} = .1432$	*K.B.C.*	.758	.773	.786	.801	.815
	K	1.175	1.2	1.23	1.27	1.31
$\frac{H}{B} = .454$	*S.B.C.*	.7925	.813	.825	.84	.855
	S	.14	.155	.17	.195	.2175
$D = 16^{1}.583$						
$P = 14^{1}.75$						
$\frac{P.A.}{D.A.} = .267$						
Blades = 3						
$T.S. = 6{,}230$						
$P \times R = 1{,}764$						
$1 - S = .86$	.845	.83	.805	.7825		
$V = 14.97$	14.71	14.45	14.01	13.8		
$I.T.D = 3.09$						
$I.H.P. = 5{,}137$						
$P.C. = .696$						
$E.H.P. = 3{,}575$						
$S.H.P. = 4{,}726$						
$v = 11$	11	11	11	11		
$v \div V = .7348$	.7479	.7614	.785	.8076		
$e.h.p. = 1{,}160$	1,200	1,260	1,370	1,580		
$e.h.p. \div E.H.P. = .3244$	.3357	.3525	.3832	.442		
Z_p (Fig. 6) $= -.51$	−.492	−.47	−.432	−.382		
$K = 1.175$	1.2	1.23	1.27	1.31		
$S.H.P._a = 1{,}716$	1,827	1,970	2,220	2,569		
Act. Power = 1,750	1,850	1,980	2,200	2,700		

after body. As the curves on Fig. 1 for estimation of *S.B.C.* are based on forward and after bodies of equal length the result may be a slight under estimate of *S.B.C.* and of *K* in the case of one or more of the vessels of the fuller nominal block coefficients.

By comparison of the estimated and actual powers it will be seen that the only difference of serious amount is with the vessel having the heaviest nominal block coefficient, as was to be expected due to the excess fullness of the after body lines over those of an equally balanced ship of the same nominal block coefficient. This difference existing is, however, too great to be credited entirely to this cause.

There is another explanation for the excess of actual power over estimated in the case of the fifth vessel, and this is, in all probability, the correct one. It will be noted that the value of *K* in this case is 1.31, while that of Z_p is —.382. Taking .382 — log *K* as the value of Z_p corresponding to the total work (load fraction) being delivered by the propeller, the value $\frac{e.h.p.}{E.H.P.}$ corresponding to this is found from Fig. 7 to be .555.

Plotting this point on Fig. 8 with $v \div V = .8076$ as ordinate, it will be found to fall below the curve of $S = .2175$ for vessels of type 2, slips of the second order. Now assume that the existence of a *K* loss produces earlier cavitation and that the propeller in the case in question is cavitating. The value of $\frac{e.h.p.}{E.H.P.}$ corresponding to the point on the curve $S =$ .2175 whose ordinate is $\frac{v}{V} = .8076$ is approximately .525 and the value of Z_p corresponding to this is .29; then the increase log factor due to cavitation is .29 — (.382 — .11727) = .02527 and the corrected value of $I.H.P._a$, taking cavitation into account, will be:

$$\text{Log } I.H.P._{ac} = \log I.H.P._a + .02527 = 3.43503.$$

$I.H.P._{ac} = 2{,}723$, which corresponds very closely with the actual power 2,700.

Now *K* undoubtedly does produce earlier cavitation; therefore, when deciding upon the design point on Fig. 8 it should be so located that the $\frac{e.h.p.}{E.H.P.}$ point, corrected for *K*, will fall well above the basic curve of *S* for the vessel. The remainder of the vessels in the McEntee problem plot above their curve of *S* when the correction for *K* is made and therefore are free from any cavitation.

Assuming that the above is correct, as it undoubtedly is, the supposition that model tank trials give no indication of cavitation is incorrect, as in the case just discussed, the model propeller is clearly indicating "dispersal of the thrust column," a term which will be explained later.

PROBLEM 2.—VESSEL OF TYPE 3

$L.L.W.L. =$	*
$B =$	*
$H =$	*
$\frac{H}{B} =$	.269
$\frac{B}{L.L.W.L.} =$	.124
$\frac{2L..I.B.}{H} =$	30.09
Nom. *B.C.* =	.577
B.C. on *A* — *B* =	.418
B.C. on *A* — *B* cor. for $\frac{H}{B} =$	.34

Slip *B.C.* on $X = .45$; $S = .0775$
$K.B.C. = .51$
$K = 1$
Number of propellers = 4
$D = *$
$P = *$
$\frac{P.A.}{D.A.} = *$
Blades = 3
Form = standard
$T.S. = *$
$P \times R = 5.772$
$1 - S = .9225$
$V = 52.55$
$I.T._D = *$
$I.H.P. = 225,740$
$P.C. = .525$
$E.H.P. = 118,510$
$S.H.P. = 207,680$
$v = 32$
$\frac{v}{V} = .609$
$e.h.p. = *$ (bare hull) $= *$ (est. all append.)
$\frac{e.h.p.}{E.H.P.} = *$
$Z_p = *$
$K = 1$
$S.H.P._a = 155,380$
Act. power = between 150,000 and 155,000

* The data omitted are confidential and therefore cannot be made public.

Having illustrated the method followed in estimating the power required to drive a vessel at any given speed against the resistance existing at that speed, it remains to explain the method of estimating the revolutions at which the propeller will turn under these same conditions of estimated power and speed, and this will be taken care of as follows:

Estimate of Revolutions Under Other Than Basic Conditions of Operation

Commander S. M. Robinson, whom the author had the pleasure of calling his assistant during the period of the great war, by laying down curves of revolutions of propellers of standard form with actual speeds through the water as abscissas derived a curve of exponents y for which the equation is as follows:

$$y = \frac{v}{v-1}\left(2.626 + \frac{5861.3}{28,045 + (v-25)^4}\right).$$

A curve of log y was also erected on v as abscissas and the values of the logs of basic V^y and v^y were denominated log A_v and log A_v.

The equation for apparent slip at any speed was found to be:

$$s = S\frac{I.H.P._a \times V^y}{I.H.P. \times v^y} = S\frac{KV^y}{10Z_p v^y},$$

or

$$\text{Log } s = \log S + \log I.H.P._a + \log A_V - \log I.H.P. - \log A_v$$
$$\text{Log } s = \log S - Z_p + \log A_V - \log A_v \text{ when } K = 1.$$

Now let $\log A_v - \log A_v = Z_v$, and, plotting it on values of $\frac{v}{V}$ as shown by curve 1 on Fig. 7, it will be found to be expressed by the equation:

$$Z_S = 2.861 \log\left(\frac{V}{v}\right) - .0788.$$

This curve reaches the value $Z_s = 0$ at a value of $\frac{v}{V} = .9385$, and this value of 0 is retained at least until $\frac{v}{V} = 1$ is reached. Beyond that the question of cavitation enters and certain variations may occur, depending upon the values of $\frac{v}{V}$ and the corresponding values of $\frac{e.h.p.}{E.H.P.}$.

The form of the equation for apparent slip where $K = 1$ now becomes $\log s = \log S - Z_p + Z_s$ and when $Z_p = Z_s$ $s = S$; that is, when the vessel is loaded down so that at any fraction of load $\frac{e.h.p.}{E.H.P.}$ and corresponding speed v, when Z_s for $\frac{v}{V} = Z_p$ for $\frac{e.h.p.}{E.H.P.}$, the apparent slip has become equal to the basic slip and the propellers are passing into the cavitating zone, with or without loss, depending upon the quality of the wake which the vessel carries.

To illustrate the method of estimating revolutions when cavitation does not exist the calculations for Problems 1 and 2 will be continued.

Before leaving the subjects of estimation of power and of revolutions, it should be of interest to note that none of the

ESTIMATE OF REVOLUTIONS

PROBLEM 1.—$v = 11$

$S.H.P._a$	1,716	1,827	1,970	2,220	2,569
$\frac{v}{V}$	.7348	.7479	.7614	.785	.8076
Z_S for $\frac{v}{V}$ (Fig. 6 — 1)	+.298	+.280	+.25	+.217	+.182
s	.1010	.1142	.126	.1510	.1798
$R_a = \frac{v \times 101.33}{P \times (1-s)}$	84.07	85.31	86.46	89	92.14
Actual revolutions	84.5	85.5	86	88	93.2

PROBLEM 2.—$v = 32$

$S.H.P._a$	155,380	Z_S	+.53
$\frac{v}{V}$	.609	s	.1965
		R_a	209.6
		Actual revolutions	208+

vessels covered by the above problems was used to any extent whatever in the derivation of the curves of design and estimating.

The processes of estimating under normal conditions having been explained, it is now necessary to take up the same subject under abnormal conditions of load, which abnormal conditions are treated under the general head of cavitation.

(*To be continued.*)

The Marine Fire Hazard*

BY FREDERICK S. TITSWORTH†

FIRE on shipboard is generally considered to be one of the most dreaded perils of the sea. It may be said without exaggeration that one-seventh of all the property lost at sea is lost by fire damage. Of the total of 835 fires which have occurred during the last six years on vessels of 2,500 gross tons or over, 544, or 65 percent, originated below decks. Of these 544 originating below decks there were 392 cargo fires, or 72 percent of all fires originating below decks were cargo fires.

Reference to the annual reports of the United States Steamboat Inspection Service covering the period 1910-1920, inclusive, reveals that of all the lives lost on the sea from all causes, approximately 2 percent were lost by fire. During the period 1916-1920, inclusive, this percentage was increased to 7. Statistics show that the casualties and deaths resulting from fire on board ship are abnormally large and proportionately far greater than they are on land.

Causes of Marine Fires

Listed below are a few of the more important causes of ship fires. These are not given in the proper order of importance or frequency of occurrence:

Oxidation of bunker coal
Fuel oil (breaking of pipes, careless filling of tanks, inflammable vapor)
Defective wiring
Harbor fires, communicated from wharves
Spontaneous combustion in cargo
Carelessness of stevedores and crew (smoking—matches)
Friction due to shifting of cargo
Rodents
Lamps and torches
Fumigation
Stoves
Lightning
Steam pipes.

It will be noted that, while many of these causes can be eliminated by special precautions of the master and crew, the majority of them are impossible of prevention in spite of all the ship operators can do. Cargoes accepted and stored are boxed in such a way as to make it utterly impracticable to ascertain their contents or whether sufficient care has been taken in packing.

Remedial Suggestions

In 1905 Section 4470 of the United States Revised Statutes was passed by Congress, providing that every steamer carrying passengers or freight shall be provided with suitable pipes and valves "attached to the boiler to convey steam into the hold and to the different compartments thereof to extinguish fire." Thus the means to extinguish fire was made mandatory, but there is no provision made for *detecting* the presence of fire. One of the fundamental principles in fighting a fire is to begin the attack as soon as combustion develops.

Based upon authority delegated by Congress in Section 4472, referred to above, the Board of Supervising Inspectors of the Steamboat Inspection Service promulgated the following regulation entitled "Automatic Fire Alarm System" (Par. 14, Ocean and Coastwise, Rule IV, Edition of May 14, 1920):

"All steamers of more than 150 feet in length under the jurisdiction of the Steamboat Inspection Service, whose construction is contracted for after June 30, 1916, which are provided with staterooms or other sleeping quarters for passengers, shall be equipped with an efficient fire alarm system or indicator which will automatically register, at some central point or station where it can be most quickly observed by the officers or crew of the steamer, the presence or indication of fire in the staterooms and *various other compartments of the steamer which are not accessible to the observation of officers or crew.*"

Although this would seem to require a fire indicating system in all the inaccessible holds and other compartments of every passenger vessel, it has never been the practice to require fire detecting systems in any other part than the staterooms and superstructure of passenger vessels. No fire detecting system has ever been required in the holds and inaccessible cargo compartments of passenger or non-passenger vessels, although statistics show that the greatest danger from fire on shipboard lies in the holds and cargo compartments on passenger and non-passenger vessels, the hazard being greater in vessels of the latter class.

The American Delegation at the International Conference on Safety of Life at Sea, which took place in London on November 10, 1913, and January 20, 1914, presented a preamble and resolutions on fire, its prevention, detection and extinguishing, which was unanimously adopted, the resolution reading as follows:

"RESOLVED: That the American Delegation proposes the following principle for the consideration of this sub-committee, and requests its adoption and endorsement:

"'That the several States signatory to this Conference agree to enact such legislation as will to the fullest possible extent provide for the prevention, detection and extinguishng of fire on shipboard, the details of the installation and application of such law to be regulated and arranged by the several signatory States.'"

Unfortunately, the forward step contemplated to be taken as recommended by this International Conference was never taken. In spite of the fact that the resolution was presented by the American Delegation, the Convention itself was not ratified by the United States.

From the above does it not seem expedient at this time for Congress to amend the Federal law and compel the installation of suitable fire detecting appliances on all passenger and non-passenger ships, particularly in the inaccessible holds and cargo compartments; such systems only to be permitted as may be approved after full inspection of the Steamboat Inspection Service?

Such a system of fire detection and extinction for use on board ship should provide the following:

(1) The means to ascertain when and where combustion is taking place before active conflagration begins, in order that the extinguishing medium may be applied immediately at the source of the fire without needlessly damaging cargo by applying an excess quantity of the medium or by applying it where it is not needed.

(2) The means to fight the fire without opening hatches or endangering the lives of the crew by sending them into smoke-filled compartments to investigate the location of the fire or to extinguish it.

(3) Means to fight the fire without unnecessarily alarming the passengers and crew.

(4) Means to determine whether or not the fire is gaining headway and spreading to other parts of the ship.

(5) Means to determine whether the fire breaks out again after having been supposedly extinguished.

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* From a paper presented before the American Society of Safety Engineers, New York, February 26, 1921.

† Walter Kidde & Company, Inc., New York.

Arc Welding Equipment at Newport News Yard

Centralized Power Station Proves More Economical Than Portable Sets

THE Newport News Shipbuilding and Dry Dock Company, Newport News, Va., has simplified the problem of furnishing power for arc welding wherever it is needed in the shipyard by concentrating its generators in one place, and distributing current to certain points from this substation. This method has proved best suited to the local conditions, and has shown an economic gain over the use of a number of single operator portable sets, not only in first cost, but in upkeep. The system is not used for welding on ships that are afloat. There welding is done with portable welding sets, the welding machine lead being grounded to the ship to prevent electrolytic action on the hull.

Several large machines working in parallel will, due to the diversity factor, permit the operation of many more welding stations than is indicated by the combined rated capacity of the generators. For example five generators having a combined rated capacity of 30 welding stations actually supply a total of 40 stations.

Equipment of the Substation

The substation contains five General Electric Company motor generator sets with their control switchboards, power being received at 440 volts alternating current from the main power station. The motor generator sets each consist of a 440 volt, 140 horsepower squirrel cage induction motor direct connected to a 94 kilowatt, 1,250 ampere 75 volt, constant potential, compound wound direct current generator, and have centrifugal safety switches for overload release. The compensators for starting the motors are mounted on the wall opposite each motor.

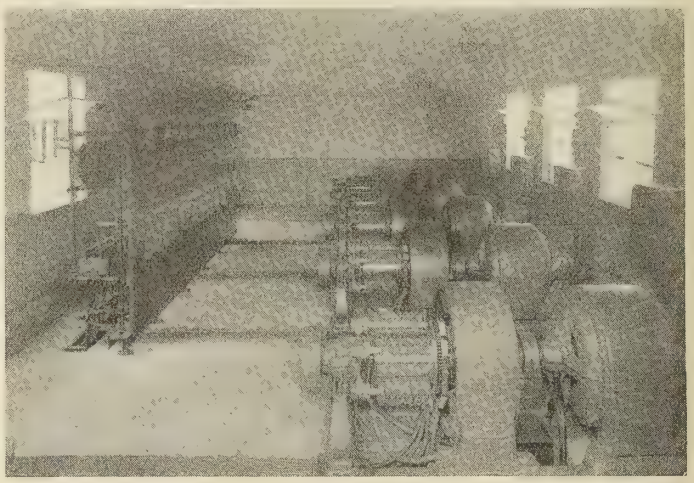
The control system for the direct current welding power consists of a switchboard which combines five standard panels, one for each generator. Each panel carries a circuit breaker, ammeter field control rheostat, voltmeter plug in receptacle, and paralleling switches for connecting the generators to the line. The voltmeter is bracket mounted, and electrically connected to the plug receptacles on the panels.

The five direct current generators may be connected, one or more at a time to a "negative" common bus or feeder circuit which is formed of five power lines. The five negative lines are carried on shipway crane trestles and branched to serve nine shipways. The "positive" return is made common by bonding all the trestles together and tying them to a positive return bus. In order to complete the welding circuit through the ships on the ways, their keels are bonded to the nearest trestle, thus completing the circuit.

How Welding Stations are Obtained

Welding stations are obtained by tapping the negative distribution lines at frequent intervals and connecting the tap to disconnecting switches located on trestles within easy reach of the operators. Between the disconnecting switches and the taps, permanent series grid resistors are inserted. The operator, to start welding, simply has to connect his electrode lead to a plug receptacle. An additional light weight portable resistor between the switch and his electrode enables the operator to adjust the current in the arc to the desired value. Such a system eliminates all temporary wiring, with the exception of the electrode leads, therefore doing away with the inconvenience and danger which are liable to arise from temporary wiring. Another advantage is that the voltage can be kept constant at all points by one operator in the substation.

As far as the economical side is concerned, in the first place this installation permits the operation of approximately 40 welding stations. The first cost of forty individual portable sets ready to operate would be about 10 percent less than the corresponding cost of the permanent installation, including building, wiring, etc., but, even so, the permanent installation is more economical for several reasons. Repairs to portable equipment made necessary by constant moving over rough ground and general knocking about would be considerable. Repairs to the permanent installation, and maintenance too, are a minimum in comparison. From a standpoint of general operating charges, such as trucking, labor and lost time, not to mention the inconveniences and danger of temporary and hence more or less careless wiring, the permanent installation, with wiring installed out of the way, good regulation and the absence of delay in moving and wiring up to the individual job, is decidedly superior. These advantages are named without any consideration of comparative power consumption.



Five 1,250-Ampere Generator Sets Used to Supply Current for Forty Welding Stations

Miniature Searchlights Used to Amplify Smoke Indications in Fire Detecting System

THE Rich system for protection against fire on board a vessel consists essentially of converting the steam smothering lines compulsory on all ships into smoke indicators. Pipes leading from each hold and compartment to the main steam line are continued up to the wheel house, where they are grouped in a detecting cabinet. When fire starts in the hold, small suction fans operating continually in the base of the cabinet exhaust the first trace of smoke through flares at the ends of the pipe lines into the cabinet against a dark background. Each tube end is properly marked so that the compartment in which the fire is smoldering can be determined immediately and the steam turned through the pipe line into the proper space to smother the fire.

To increase the certainty of detecting the first sign of smoke an underlighting system of miniature searchlights has been arranged in the base of the cabinet so that a beam of light is directed from the end of each pipe. Any smoke now issuing from the flare is thrown into prominence immediately. The searchlight effect is obtained by means of two ordinary incandescent lamps in the base of the cabinet, the light from which is directed against a system of lenses and mirrors set in brass castings in the pipe lines. When smoke is once indicated in the detecting cabinet, live steam is turned through the pipe lines into the compartment on fire. Fires may thus be controlled before they have reached dangerous proportions.

Balancing Engines

With Special Reference to Internal Combustion Engines

BY C. H. PEABODY, DR. ENG.

THE balancing of engines has been treated as a recondite subject to be handled carefully by experts; even now many believe the direct mathematical treatment to be too difficult, and in order to avoid it employ graphical processes or approximate calculations. And yet ready methods with convenient tables are to be found in certain text-books which, however, do not appear to be generally known. The computation of tables is tedious, but that concerns the practitioner as much and no more than the compilation of tables of logarithms. Even some of the obvious applications to automobile engines have been heralded as revolutionizing discoveries.

Acceleration

Some of the trouble may be due to the fact that, while all can talk glibly of velocity and acceleration, the fundamental conception may not be clear and mystery leads to obscurity. Perhaps a simple presentation of the fundamental may be interesting even to the initiated and may clear away mysteries to those less familiar.

If a heavy body is dropped it will fall about 16 feet the first second, 64 the next second and so on, as given in the following table:

Time	Distance	Velocity	Acceleration
0	0	0	..
1	16	32	..
2	64	64	32
3	144	96	32
4	256	128	32
5	400	160	..
6	576	...	..

If some one wants to be finicky, he will add a small fraction to the 16, depending on latitude and altitude, and will

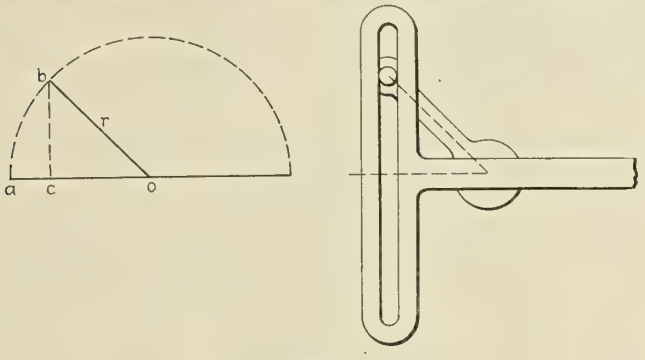


Fig. 1

begin to worry about atmospheric resistance; but let the table be granted as a first approximation. We are familiar with velocity as given by the speedometer, especially if we have reason for exceeding the speed limit, but that is in miles per hour. If the mile were only 6,000 feet ashore as it is at sea, then sixty miles an hour would be 100 feet per second. In what follows velocity per second will be used. Now the way to test velocity is to measure the time over a known distance. That is what the traffic officer does, but many would like to believe he does not know how to calculate.

For first approximation let us calculate the velocity of falling by this method. In two seconds a body falls 64 feet, and dividing by two gives the velocity as 32 feet at the middle point of time. In the two seconds from 1 to 3 the body falls 144 minus 16 feet, or 128 feet, half of which is 64, the velocity at 2 seconds, and so on through the table. The rate of increase in velocity is called acceleration; it can be computed from the velocity by an extension of the same method. Thus, the velocity at the end of one second is 32, and at the end of the third second it is 96; half the difference is 32. This last is the acceleration due to gravity, which is commonly quoted as 32.2 and which gets into almost all equations for dynamics.

It appears from the above discussion that the acceleration due to gravity is constant; it is constant at a given place. Consequently the method used is exact, because a uniform increase in velocity will make a body fall half as far in a second as it would fall at constant full velocity. The real proof of the gravitation system is its use in calculating the orbits of the moon and other heavenly bodies.

Mass

It has been agreed that force shall be measured by the product of the mass by the acceleration. A pound weight is pulled down by gravity with the force of one pound. Its mass is, therefore,

$$1 \div 32.2 = \frac{1}{32.2} = \frac{1}{g},$$

and the mass of a body weighing w pounds is

$$m = \frac{w}{g}.$$

Physicists like to speculate about mass, and engineers are not uncommonly afflicted by the same tendency. The usual definition is that mass is the amount of matter in a body; which does not mean anything and we will let it go at that.

Harmonic Motion

The next simplest acceleration to that of gravity is acceleration of a slotted crosshead, shown in Fig. 1. Suppose that the crank starting at the dead point a has moved through the angle a-o-b, and that the crosshead has moved the distance $ac = r - r \cos a\text{-}o\text{-}b$. To find the velocity at this position we will divide a small movement by the time taken to go to it. For a first approximation we will take a movement of 10 degrees of the crank, half on one side and half on the other. Thus if a-o-c is 30 degrees we will calculate for 35 degrees and 25 degrees, giving

$$ac_{35} = r - r \cos 35 \text{ degrees} = r - 0.9063r,$$
$$ac_{25} = r - r \cos 25 \text{ degrees} = r - 0.8192r,$$

the difference being $0.0871r$.

Now the time taken by the crank to go 10 degrees will be

$$\frac{10}{360} \div \frac{n}{60} = \frac{1}{36} \times \frac{60}{n},$$

where n is the number of revolutions per minute. This time is likely to be a small fraction of a second.

Dividing the distance by the time, we have for the velocity

$$v = \frac{nr}{60} \times 36 \times 0.0871 = \frac{nr}{60} \times 3.136.$$

The next operation is to multiply and divide by the ratio of the crank to the circumference of the circle; that is, by

$$2\pi = 2 \times 3.1416 = 6.2832.$$

This looks a good deal like a trick, especially as we get a desirable result; that is,

$$v = \frac{2\pi nr}{60} \times \frac{3.136}{6.2832} = \frac{2\pi nr}{60} \times 0.5 \text{ (approximately)},$$

where we may recognize that 0.5 is the sine of 30 degrees, so that the velocity becomes

$$v = \frac{2\pi nr}{60} \text{ sine 30 degrees.}$$

The reason for using the trick is that the differential calculus shows that this is the exact expression for the velocity. In fact, we may write, as a general expression,

$$v = \frac{2\pi nr}{60} \text{ sine } a\text{-}o\text{-}b = \frac{2\pi nr}{60} \text{ sine crank angle.}$$

The next step is to get the acceleration by dividing a small increase in velocity by the time required to gain it. The numerical work is like that just given, taking sines at 35 degrees and 25 degrees and their difference. The time required is the same as that used, and we resort to the same trick of multiplying and dividing by 2π. Omitting the numerical work, we may write the result as

$$a = \frac{4\pi^2 n^2 r}{3{,}600} \cos 30 \text{ degrees;}$$

or in general for any crank angle

$$a = \frac{4\pi^2 n^2 r}{3{,}600} \text{ cosine crank angle.}$$

Instead of making calculations for each particular case, it is convenient to compute a table, and since the length of the crank and the number of revolutions per minute vary from engine to engine we may compute an acceleration factor

$$\frac{a}{n^2 r} = \frac{4\pi^2}{3{,}600} \cos \text{ crank angle.}$$

TABLE I.—ACCELERATION FOR HARMONIC MOTION

Multiply factors by n^2r

n = revolutions per minute

r = length of crank in feet

Sign of factors negative 90 degrees to 180 degrees and 180 degrees to 270 degrees

Crank Angles	Acceleration Factor	Crank Angles	Acceleration Factor
0-360	0.0110	100-260	0.0019
10-350	0.0108	110-250	0.0038
20-340	0.0103	120-240	0.0055
30-330	0.0095	130-230	0.0071
40-320	0.0084	140-220	0.0084
50-310	0.0071	150-210	0.0095
60-300	0.0055	160-200	0.0103
70-290	0.0038	170-190	0.0108
80-280	0.0019	180-180	0.0110
90-270	0.0000		

To illustrate the use of this table of accelerations, let us solve a problem. Since slotted crossheads find little use in practice, the problem must be made up and may as well be a simple one. Suppose that a pump with a slotted crosshead makes 60 revolutions per minute, that the length of the crank is 6 inches and that the piston, piston rod and crosshead together weigh 100 pounds.

The acceleration factor at the beginning of the stroke from the table is 0.0110. This factor is to be multiplied by

$$n^2 r = 60^2 \times \tfrac{1}{2} = 1{,}800;$$

$$\text{acceleration} = 1{,}800 \times 0.0110 = 19.8.$$

This may be compared with the acceleration due to gravity 32.2 feet per second. The significance of this is that the force required to accelerate the piston and attached parts is less than the weight of them.

Having in mind that a force is measured by the product of the mass and the acceleration, we may now calculate the force at the beginning of the stroke as follows:

$$\frac{100}{32.2} \times 19.8 = 60.2 \text{ pounds.}$$

A little study of the table will give useful information. Thus the acceleration for a crank angle of 60 degrees is half that for 0; the factor is then 0.0055 as compared with 0.0110. For that angle the movement of the piston is

$$r - r \cos 60 \text{ degrees} = r\ (1 - 0.5000) = \tfrac{1}{2}r.$$

That is to say, the piston is then at one-quarter stroke. At 90 degrees the acceleration is zero, and then it changes sign and becomes a retardation, and the force for a retardation is measured by the product of the mass by the retardation (negative acceleration). At the other quarter stroke the factor is —0.0055, and at the end of the stroke the factor is —0.0110. From this we see that the acceleration decreases uniformly during the first half stroke and that the retardation increases uniformly during the second half stroke.

Since the factors are multiplied by n^2r, it is evident that the accelerating force increases as the square of the revolutions and as the length of the crank. Thus, if we double the speed, the accelerating force becomes four times as great. On the other hand, doubling the stroke (or the crank) only doubles the accelerating force. Either method would double the capacity of the pump. Of course doubling the stroke would mean building a new pump, while doubling the revolutions would mean wearing the pump out sooner.

CRANK AND CONNECTING ROD

The reason for handling the balancing of engines so gingerly is seen when we find from Fig. 2 that the displacement of the piston from the beginning of the stroke is

$$s = l + r - r \cos \theta - \sqrt{l^2 - r^2 \sin^2 \theta}.$$

The derivation of this equation and the method of computing the acceleration will be put in an appendix following

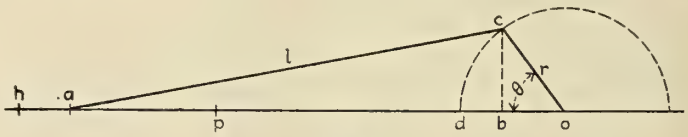


Fig. 2

this section of the discussion of balancing engines. Those familiar with differential calculus will follow the work readily. For our present purpose we may use the following table, which has been properly computed and verified:

TABLE II.—TABLE FOR ACCELERATION OF CROSSHEAD

Multiply factors by n^2r

n = revolutions per minute

r = length of crank in feet

Crank Angles	Ratio of Connecting Rod to Crank 4	4½	5	5½
0-360	0.01371	0.01340	0.01316	0.01296
10-350	0.01338	0.01309	0.01291	0.01268
20-340	0.01243	0.01219	0.01200	0.01184
30-330	0.01091	0.01075	0.01062	0.01051
40-320	0.00893	0.00886	0.00881	0.00877
50-310	0.00662	0.00665	0.00669	0.00672
60-300	0.00411	0.00427	0.00439	0.00449
70-290	0.00161	0.00185	0.00205	0.00221
80-280	0.00075	0.00044	0.00020	0.00000
90-270	0.00283	0.00250	0.00224	0.00203
100-260	0.00456	0.00425	0.00400	0.00381
110-250	0.00589	0.00565	0.00545	0.00529
120-240	0.00685	0.00670	0.00658	0.00648
130-230	0.00749	0.00745	0.00741	0.00738
140-220	0.00788	0.00794	0.00799	0.00804
150-210	0.00808	0.00825	0.00837	0.00848
160-200	0.00818	0.00842	0.00861	0.00877
170-190	0.00822	0.00850	0.00869	0.00892
180-180	0.00822	0.00853	0.00877	0.00897

The sign of the acceleration constant is positive from 0 degrees to 70 degrees, and negative from 70 degrees to 180 de-

grees. From 180 degrees to 290 degrees the sign is again positive and finally is negative from 290 degrees to 360 degrees. The factor becomes zero somewhere between 70 degrees and 80 degrees.

To show the use of the table, we will compute the accelerating force acting on the piston and connecting rod of an automobile engine. In order to have a real problem the writer stepped into the nearest automobile station, which happened to deal in the Jordan car. Parts were very courteously produced and weighed, with the following results:

	Pounds
Piston, rings and pin	3.25
Connecting rod	3
Crank pin end	2
Wrist pin end	1

The stroke is 5.25 inches and the length of the connecting rod is twice as much, i. e., it has four times the length of the crank. The body of the rod is slender and it will be sufficient to add the weight of the wrist pin end to the weight of the piston, making the combined weight 4¼ pounds. The weight of the crank pin end may be assumed to be applied at the crank pin; its influence will be considered later. The stroke of the piston being 5¼ inches, the length of the crank in feet will be

$$\frac{5\frac{1}{4}}{2 \times 12}.$$

To get the acceleration, we will take the acceleration factor from Table II at 0 degrees and multiply by n^2r. To find the force required to accelerate the piston we must further multiply by the mass—that is, by the weight divided by 32.2. Finally we shall have for the force required to give motion to the piston at the top end of the stroke

$$(750)^2 \times \frac{5.25}{2 \times 12} \times 0.01371 \times \frac{4.25}{32.2} = 223 \text{ pounds.}$$

A similar calculation for the bottom end of the stroke, using the factor 0.00822 from Table II, is 134 pounds.

There are two very important pieces of information to be had from this calculation. First, that we are dealing with large forces and, second, that the accelerating forces at the two ends of the stroke are very unequal. The top end force is more than fifty times the weight of the piston and attached parts, and it is nearly 1.7 times the force at the bottom end. This information cannot be over-emphasized if we are to give intelligent attention to balancing engines.

We will pause to bring out one more point from Table II before proceeding, namely, that the inequality of the acceleration at the two ends of the stroke decreases rapidly with the length of the connecting rod. Thus when the rod is 5½ times as long as the crank the ratio drops to 1.4; this shows the advantage of longer rods.

Appendix

In Fig. 2 let o be the center of the crank shaft, let hp be the stroke of the crosshead, let r be the length of the crank, and l be the length of the connecting rod; then the displacement of the piston from the beginning of the stroke is

$$s = ha = hd + do - ob - ab.$$

Here hd is the length of the connecting rod, do is the length of the crank and the other terms are

$$ob = r \cos \theta,$$
$$ab = \sqrt{(ac)^2 - (cb)^2} = \sqrt{l^2 - r^2 \sin^2 \theta},$$

so that

$$s = l + r - r \cos \theta - \sqrt{l^2 - r^2 \sin^2 \theta}.$$

It is convenient to give the crank angle in terms of the angular velocity α of the crankpin, so that if t is the time required for the crank to pass from the dead point d to the position oc, then

$$\theta = \alpha t.$$

Consequently the displacement of the crosshead from the beginning of the stroke is

$$s = l + r - r \cos \alpha t - \sqrt{l^2 - r^2 \sin^2 \alpha t}.$$

The velocity v is found by differentiating with regard to t.

$$v = \frac{ds}{dt} = \alpha r \sin \alpha t + \frac{\alpha r^2 \sin \alpha t \cos \alpha t}{\sqrt{l^2 - r^2 \sin^2 \alpha t}}.$$

$$v = \alpha r \sin \alpha t \left\{ 1 + \frac{r \cos \alpha t}{\sqrt{l^2 - r^2 \sin^2 \alpha t}} \right\}.$$

Differentiating again to get the acceleration

$$a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$$

$$= \alpha^2 r \cos \alpha t \left\{ 1 + \frac{r \cos \alpha t}{\sqrt{l^2 - r^2 \sin^2 \alpha t}} \right\}$$
$$+ \alpha r \sin \alpha t \{ - \alpha r \sin \alpha t \, (l^2 - r^2 \sin^2 \alpha t)^{-1/2}$$
$$+ r \cos \alpha t \, [(l^2 - r^2 \sin^2 \alpha t)^{-3/2} \, (\alpha r^2 \sin \alpha t \cos \alpha t)] \}$$

$$a = \alpha^2 r \left\{ \cos \alpha t + \frac{r (\cos^2 \alpha t - \sin^2 \alpha t)}{\sqrt{l^2 - r^2 \sin^2 \alpha t}} + \frac{r^3 \sin^2 \alpha t \cos^2 \alpha t}{(l^2 - r^2 \sin^2 \alpha t)^{2/3}} \right\}.$$

These equations may be written as follows:

$$s = r \left\{ 1 + \frac{l}{r} - \cos \theta - \sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta} \right\}.$$

$$v = \frac{ds}{dt} = \alpha r \sin \theta \left\{ 1 + \frac{\cos \theta}{\sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta}} \right\}.$$

$$a = \frac{d^2s}{dt^2} = \alpha^2 r \left\{ \cos \theta + \frac{\cos 2\theta}{\sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta}} + \frac{\sin^2 2\theta}{4 \left\{ \left(\frac{l}{r}\right)^2 - \sin^2 \theta \right\}^{3/2}} \right\}$$

The calculation of the factors for Table II is made by replacing the angular velocity a by its value $\frac{2\pi n}{60}$ and then solving for $\frac{a}{n^2 r}$ so that

$$\frac{a}{n^2 r} = \frac{4\pi^2}{3{,}600} \left\{ \cos \theta + \frac{\cos 2\theta}{\sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta}} + \frac{\sin^2 2\theta}{4 \left\{ \left(\frac{l}{r}\right)^2 - \sin^2 \theta \right\}^{3/2}} \right\}$$

So far as the writer knows, this equation was first derived by Professor Gaetano Lanza about 1885 and was used by him for computing tables of acceleration. A complete treatment of the dynamics of reciprocating motion and many other motions is given in his "Dynamics of Machines." The discussion here presented is abstracted from the writer's "Computations for Marine Engines," and the tables here given are taken from that book with the permission of John Wiley & Sons, the publishers of both books mentioned above.

(To be concluded.)

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The Shipping Board

THE mere appointment of a new chairman for the United States Shipping Board will not end its troubles. As matters now stand, the chairman is such in name only; for the Merchant Marine Act, 1920, says, "The duties of the board may be so divided that under its supervision the directorship of various activities may be assigned to one or more commissioners." While "may" is not "shall," nevertheless no specific authority or assignment is given to the chairman, and the board is actually functioning as a several-headed rather than a single-headed body.

What is needed is a real chairman with real authority, the whole commission to function just as the board of directors of any well-organized business institution functions. It should confine its deliberations largely to policies, leaving it to well paid, competent subordinates to carry out those policies. This plan is especially essential because it is probable that but few if any of the commissioners will be drawn from the one place from which all should be chosen—the American merchant marine field. If each member of the board is to continue to function as in the past, with discretion as to the different departments of ship operation; if the active manipulation is to rest with a lot of incompetents; and if master and man alike are to be subject to the beck and call of politicians, then better by far that the whole board be legislated out of existence and its powers transferred to the Department of Commerce. As a matter of fact, why not that course anyway?

Obsolete Tonnage

ACCORDING to Sir Owen Phillips, Great Britain has over 3,000,000 gross tons of merchant ships that have been over twenty years in service. Not only has Great Britain a large number of old vessels but all other maritime countries have kept in service and resurrected anything in the shape of a ship that would keep afloat. Although there are certain routes where obsolete vessels may still be profitably kept in service the greater portion of these old timers cannot hope to compete with newer ships in the strenuous times that are before us and they should be broken up and given to the junk man.

Although the greater part of our merchant fleet is of recent construction, many of the ships that are at present tied up, including wooden vessels and also steel ships which have not received proper care, might properly be classed as obsolete. In addition to this, and due to the fact that the most of the vessels built during the war were designed for one purpose, we have a number of ships that will be useless until normal trade is resumed. There are a number of special types, however, including passenger vessels and refrigerator ships, of which latter type Great Britain has 272 built and 49 building, that we could profitably use even if they had been a fairly long time in service.

In addition to the special types of vessels that we are in immediate need of, the fact that ships do grow old and become antiquated in about 20 years is another source of encouragement to the shipbuilders because the world's tonnage cannot decrease at the rate of 5 percent per annum for any considerable length of time without a demand for new tonnage to make up the deficiency.

Vessels for Lighthouse Service Urgently Needed

THE Lighthouse Service of the Bureau of Commerce will require in the next three years at least thirty new ships, consisting of light vessels and tenders. While the average age of an ordinary ship is twenty years, of the light vessels now in use twenty are more than thirty years old and of the tenders seventeen are more than twenty-five years old. In order to maintain this service efficiently the Lighthouse Bureau has emphatically recommended the construction of at least four vessels a year, but since 1910 only eighteen ships have been built, which is less than half the number that is absolutely necessary to maintain the Service on its former basis, without allowing for any increase. Since 1910, however, this Service has been greatly expanded and the three new districts of Alaska, Porto Rico and Hawaii have been added, which has so increased the work of the tenders that, even were they efficient modern vessels, their present number would be inadequate to maintain the proper service required to render navigation safe.

Many of the present tenders are of an unsuitable type to perform the heavy work that is required of them and some are not even seaworthy. Outside of the fact that both lighthouse tenders and lightships are engaged on very hazardous duty and that their officers and crews should not be required to serve on vessels which are not reasonably safe, it is false economy to keep in commission vessels that are so old that a great deal of extra time and money must be spent in repairing and overhauling.

Considering the vast sums of money that have been spent on our Navy and merchant marine, the relatively small cost of maintaining an efficient Lighthouse Service should be considered from a business standpoint as the best kind of insurance. Light vessels are floating lighthouses stationed on very hazardous positions guarding the dangerous points of the coast and they are equipped not only with lights but

also fog signals, submarine bells, and radio communications, all of which are most indispensable aids to navigation.

The tenders are the arteries by which lighthouses, light vessels and buoys receive the necessary supplies and also inspections and they maintain a continuous patrol of the coast, frequently rendering aid to ships in distress. They handle buoys of great weight and in placing them they must navigate close to reefs and shoals and in waters that other vessels are careful to avoid.

The building of vessels for this service should not be postponed as the fleet is in a seriously depreciated condition. None of the Shipping Board vessels is adaptable, as the ships required are of a highly specialized and staunch type requiring high freeboard, closely spaced frames, special shape of midship section to give the least resistance to the mooring lines and many other features. A great deal can be saved by constructing a number of those vessels of one type at the same time and Congress would do well to consider whether it is not a good business, as well as humane policy, to authorize the construction of these ships at once, even if it is necessary to part with a few cargo vessels at bargain prices to get the money.

The Ter Meulen Plan

THE Ter Meulen Plan, which is receiving very favorable consideration in England, provides a basis for financing the importers of those nations which under present circumstances are unable to obtain long term loan accommodations on reasonable terms in the open market. The details of this plan, which is composed of sixteen sections, have been redrafted by the Provisional Economic and Financial Committee of the League of Nations. It proposes to establish an international commission of bankers and business men of high standing to consider the value of the security that any country is prepared to give as a basis for granting credits to their importers. The commission will determine the gold value of the security and the participating government will be authorized to issue bonds to the amount which is specifically secured out of the revenue of the assigned assets. The participating governments will be free to pledge their own bonds as security for the payment of imports or to lend them to their nationals to be used as collateral for credits or long term loans for approved imports on private account. The bonds cannot be used for any purpose other than security for imports and must be countersigned by the commission.

As the fundamental purpose of this scheme is to make it possible for impoverished countries to secure the raw materials and products that are necessary to start their industries, only those commodities which will assist in stimulating production will be allowed to be imported on this type of security. Each country is to be required to draw up a schedule of approved imports and this with the particulars of each transaction must be registered with the commission. After these bonds are issued the importer may pledge them with the exporter who shall hold them as long as the terms are complied with and return them to the importer when full payment is made. In the event of the importer not fulfilling his contract the exporter may sell the bonds on the public market after giving reasonable notice to the government issuing them, which shall have the first opportunity to purchase.

It will be noted that this scheme takes care of the importer, but leaves the exporter to finance himself. In this country provision has been made for financing the exporter through banking corporations organized under the Edge amendment to the Federal Reserve Act. One of these companies, the Foreign Trade Financing Corporation, has appointed a committee of bankers and business men to study the value of foreign securities and should they decide that the Ter Meulen plan offers a uniform and safe security, and England, who actually buys our products to sell to other countries on credit, apparently thinks it does, then we will have progressed a long way toward solving the financial problems connected with our foreign trade. In any case some means must be found whereby we can sell our surplus products—and this matter is just as vitally important to the farmer, the miner and the manufacturer as it is to our merchant marine.

The Seattle Spirit

NO better method of developing the enthusiastic support of our merchant marine has been shown than the manner in which the new Shipping Board passenger ship *Wenatchee* was welcomed on her arrival in Seattle. Ocean-going ships, excursion boats, naval craft and a mosquito fleet met the liner in the straits of Juan de Fuca and convoyed her all the way to the Queen city. On the way down the sound the vessel was greeted with salvos from the various forts while aeroplanes circled above her and upon her arrival at Smith Cove she was welcomed with the cheers of thousands, the exploding of aerial bombs and the blowing of syrens and whistles. The Governor of the state and the mayors of Seattle and Wenatchee were present and delivered congratulatory speeches making the event of the establishment of an American-owned and operated passenger service between Seattle and the Orient a time of rejoicing.

Seattle has long had transpacific passenger service but it has been furnished by British and Japanese lines and it is most encouraging to note that the warm reception given to the *Wenatchee* argues well that the support that this ship and the four other passenger vessels assigned to the service will get from this community will be of sufficient strength to permit of successful competition with the existing foreign lines.

Seattle has always been a good advertiser of its resources and advantages but on the other hand it has spared neither energy nor capital to accomplish stupendous engineering projects. The scenic city is one of the healthiest in the world but the climate has been supplemented by a determination to make it the cleanest. The hills in the business district have been leveled at an enormous cost and the harbor and inland lakes have been highly developed and connected by a canal so that the port facilities are of the best.

Undoubtedly the city's geographical location, which is materially closer to the Orient than her southern rivals, has had its influence with the Shipping Board in the allocation of the above-mentioned vessels, as the operating cost of a ship of the *Wenatchee* class is approximately $5,000 per day.

However, Seattle wanted the ships, and the business advantages that it will reap as a result of the establishment of this service are many, but what is true of the benefits of an American merchant marine to this city is also applicable to the whole country. It is right to do those things that are proper in an enthusiastic manner and to let the world know it and we are glad to learn of one more evidence that the Seattle spirit is behind our merchant marine.

Standardizing Joiner Work

JOINER work has always been a knotty problem to the marine estimator. Although many methods have been tried for reducing the cost of this important work to a unit basis for estimating, the designers have caused the failure of all by continuing to introduce special features into the wood work aboardship where a duplication of some standard would do just as well and be a great deal more economical.

In conformity to the above ideas it is understood that several yards are designing standard staterooms with a view to incorporating them on new ships to be built. This practice is to be commended as it allows a large part of the work to be carried out with celerity and at less cost without detracting any from the general appearance.

Sale of Shipping Board Vessels

ONE of the most important problems that will confront the new Shipping Board is how are government ships to be sold to private interests in conformity with the plainly expressed principles of the Merchant Marine Act. It has been the fashion lately with some of our most prominent shipowners continually to express the opinion that these ships cannot be sold at any price at the present time. The truth of the matter is that they cannot be sold at anywhere near the price that the Shipping Board has been asking for them or what it would cost to reproduce them, and this state of affairs is largely due to the world-wide depression in business and the lack of indirect or direct protection for American shipping.

Even without protection in the way of subsidies or discriminatory duties these ships could be sold at a price which would enable them to ocmpete on fair terms with foreign ships. What this price should be cannot be arbitrarily fixed at so much a deadweight ton because there is a wide divergence in the types and quality of the ships. Added to this, there is a great difference in the earning possibilities of the various trade routes and also the question of the coastwise trades, which are restricted to vessels flying the American flag.

One prominent shipowner has suggested that the average book values of English vessels be ascertained as a basis for fixing the prices of our government vessels; but if the administration is not going to enforce the preferential rail rates and the discriminatory duties, it is questionable, even then, whether the American vessels can compete with foreign ships having lower operating costs.

Another shipowner, who has been successfully operating a coast to coast service, has suggested a plan for the sale of Shipping Board vessels which deserves our serious consideration. Briefly, it proposes that the ship operator should make a careful study of the operating costs for a particular type of vessel on a particular trade route and from these data decide what price he can pay for a desired ship and have a reasonable chance of success. He is then in a position to make an intelligent bid which the Shipping Board may accept or offer a counter proposal as to what price it will accept. Assuming that the government desires to place its ships in private hands as directed by the Jones Bill, and at a price that will enable the operator to survive, an agreement could be reached or failing this the usual method of arbitration by a third and disinterested party could be obtained. It is believed that if the Shipping Board would meet prospective purchasers on a price based on operating costs there would be very few cases where arbitration would be necessary in order to determine the price and, what is more important, it would then be possible to interest the public in investing in shipping securities.

Our Naval Program

THE present plans of the Navy Department call for the completion in 1925 of 114 of the latest type of warships. Of these vessels 11 are battleships, 6 battle cruisers, 10 light cruisers, 38 destroyers and 43 submarines. These vessels, having a grand total of 842,109 tons displacement, will more than double the present strength of our Navy and make it equal in size and efficiency to that of Great Britain.

No reduction in this program should be permitted either for economic or disarmament reasons. We can better afford to have a Navy adequate in size to efficiently protect our safety and interests than any other nation. If disarmament agreements are entered into they should be on the basis that this country should have as large a share of the international naval police force as any other and if disarmament agreements are not consummated then there are so many reasons why he should have a big navy that it would take more space than we have available to enumerate them.

The Navy should not be looked upon as an aggressive weapon in the sense of being used to conquer other nations. It takes an army to occupy territory and we have no intention of establishing an invasive force, but the Navy can protect our merchant marine and our foreign interests and it can meet in offensive or defensive action a foreign fleet far enough away from our shores to prevent serious interference with our domestic pursuits. It is the cheapest and most efficient protective insurance that we can invest in and the only means of enforcing such principles as the Monroe Doctrine, the Open Door in China and the Freedom of the Seas.

With our long shore line, the Panama Canal and our island possessions, Congress should not hesitate to grant such appropriations as are necessary to complete this program. Business men should exercise not for the purpose of being able to whip somebody but to keep in condition to repel the microbes of disease. A big Navy means that the United States will be kept in physical condition to prevent the germs of envy or discord which still exist among nations as among men from causing our destruction.

LETTERS TO THE EDITOR

New York Marine Exposition

The suggestion of a marine exhibit at New York at the time of the meeting of the Society of Naval Architects and Marine Engineers is a good idea and cannot fail of success. It is the right kind of intensive advertising, bringing to the attention of shipbuilders and ship designers the equipment they need to complete the outfit of their ships; and better yet it will bring the makers and the purchasers of the equipment together personally. It would be still better if the deck officers and the engineers of steamships could get together with the manufacturers and the shipbuilders. They could talk over and compare all kinds of equipment and each of the three groups could give advice and could learn.

C. H. Peabody, Dr. Eng.

Washington, D. C.

The Determination of Brake Horsepower

In an editorial in the March issue of Marine Engineering on "The Determination of Brake Horsepower," reference is made to the electric cradle dynamometer in a way which we feel is confusing to the reader, who would gather from reading it that the electric dynamometer was essentially an unusual or complicated device.

It is perfectly true that the electric cradle dynamometer for very large powers is high in cost compared to the water brake or hydraulic dynamometer, but for flexibility and convenience of operation the electric dynamometer has no equal. The editorial refers to the machine as being used by "electrical engineers." As a matter of fact, it is used far more by mechanical engineers and internal combustion engine designers than by electrical men. We quote below from an address by J. G. Vincent, lately Lieutenant-Colonel in the U. S. Army Air Service, presented to the engineering students at Yale University on May 7, 1920:

"There are two distinct methods of testing an engine; one, a dynamometer test, and the other, a test after installation in the car, truck, tractor, plane or boat, as the case may be. Both kinds of tests are necessary, each method permitting of acquiring certain data indispensable to a complete understanding of the subject. The dynamometer represents a means of absorbing power and may consist of a prony friction brake, a water brake, a fan brake or an electric-cradle dynamometer. I will describe only this latter form, since it is immensely superior to the other types and is universally used, at least in this country."

C. F. Scott,

Manager Apparatus Department, Sprague Electric Works.

New York.

Motorboat Standards

Some conception of what engineering standardization can do for an industry may be gathered from the work that has already been done in this direction by designers and engineers in the automobile field. There are at present more than two hundred definite automotive standards being used, the natural result being an inestimable saving in production costs. What is perhaps even more important, a minimum "factor of safety" has been made a part of some of these standard specifications, thus insuring to the ultimate user of the finished product not only excellence of materials used, but also the prolonged life and sustained performance of the equipment itself.

What has been done in other industries can be done, to a degree, in the motorboat industry. One of our leading builders has aptly stated: "The builders with a large amount of invested capital realize that standardization is imperative, and concerns with only a small capital must either soon come to it or gradually pass out of business."

The Motorboat Standards Division of the Society of Automotive Engineers, embracing a personnel of some of the best-known men in the motorboat industry, has been engaged in the formulation of marine standards and recommended practices for several years past. Some progress has been made, and that committee is now seeking suggestions from builders, designers, engineers and others in the trade as to what practices might be recommended in the construction and equipment of motor craft, with the probability that in due time these practices may find universal favor and be formally adopted as standards. Suggestions may be sent either to the writer or to Mr. Joseph C. W. Van Blerck, vice-president, Society of Automotive Engineers, 29 West 39th street, New York City.

New York. Ira Hand, Secretary,
National Association of Engine & Boat Mfrs., Inc.

NEW BOOKS

Metallic Packing

Metallic Packing. By Julian N. Walton. Pages, 87. Illustrations, 54. Size, 8 by 5 inches. Chicago, Ill., 1920: Crane Packing Company.

This book is being distributed by the Crane Company to designers, manufacturers and operating engineers to assist them in understanding more fully packing problems and to help them in overcoming packing troubles. The theory and practice in using various successful types of packing are thoroughly discussed in the first chapters of the book. Split case and split ring metallic packing preceded the various granulated and plastic types which were intended to meet the demand of flexibility and compressibility. The Crane packing as finally developed embodied the properties of these types with the advantage of full flexibility which had previously been lacking. For packing valve stems and rods, reciprocating rods on pumps and air compressors and the like this material is specially adapted. High speed shafts of centrifugal pumps operating under high pressures depend on leakage through the packing for lubrication. With Crane packing the stuffing box leakage is controlled to the exact amount to provide this lubrication. In turbine practice this packing forms a permanent seal of the steam shaft; for refrigeration and acid service special packing containing wiper rings is used to eliminate any trace of vapor that might pass through the stuffing box. Notes on the design and charts giving the general proportions of stuffing boxes are included in the book for the use of engineers called upon to design stuffing boxes for all services and pressures.

Ore and Coal Carriers Chilore and Lebore

(*Concluded from page 367.*)

is no comparison between the strength of this and the new vessels. It is interesting to compare the *Chilore* and *Cubore*, both ore and coal steamers, as this factor jumps from 2.95 in the case of the *Chilore* to 3.56 for the *Cubore*, although the block coefficient is .02 less in the case of the latter. The Lake ore steamer has a factor in close agreement with the larger Bethlehem steamers, but this comparison is of no particular value on account of the limited draft of the lake vessels and the resulting relatively small deadweight. If this vessel was given a permissible freeboard, the deadweight carried per ton of steel would be very much higher.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permision to do so.

Calculations for Strength of Ships

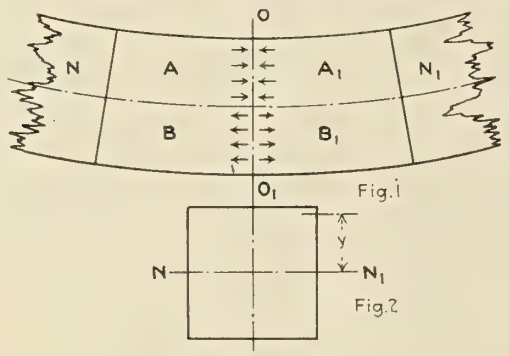
Q. (1118).—I recently purchased a book on ship production in which appeared the following paragraph:

"The maximum bending moment and the point at which it occurs are then determined, and calculations for the strength of the ship at this point are made to see that this strength is sufficient. This is done by finding the moment of inertia of this section and calculating the maximum fiber stress, making use of the ordinary beam formula $\frac{p}{y} = \frac{M}{I}$."

I would like to learn the meaning of the "p," "y," "M" and "I" as used in the above. I take the "M" to mean the bending moment and the "I" the moment of inertia, but cannot understand the "p" and "y" in the above. L. J. I.

A. (1118).—The formula to which you refer expresses the relationship between bending moment, M; moment of inertia, I; unit stress, p; and the distance from the neutral axis to any given point, usually the outermost, of the cross section, y. (See Figs. 1 and 2.) This relationship holds for beams of uniform cross section and homogeneous material upon which the forces, both of support and load, act in a common plane and perpendicular in each case to the neutral axis of the unbent beam.

A proper understanding of the action of the ship as a girder when subjected at once to the loads due to the weights of her structure, machinery, cargo, etc., and to the supporting forces of the water can be best obtained through a thorough study of the flexure of ordinary beams. Any standard work on applied mechanics, such as "Mechanics of Materials," Merriman; "Mechanics of Engineering," Church; or "Applied Mechanics," Lanza, will afford the basis for such a



Figs. 1 and 2

study. If the information is desired in more compact form, reference may be made to the "Mechanical Engineer's Pocket Book," Kent; or to other similar works.

The following, while in no sense intended to take the place of the study just suggested, may be of value in connection therewith.

Let Figs. 1 and 2 represent, respectively, an elevation and a cross section of a simple beam loaded on its concave and supported on its convex side.

(a) The moment of inertia of any cross section is the sum of the products found by multiplying each elementary area of the cross section of the beam by the square of its distance from the neutral axis of that section. Formulæ for calculating the moments of inertia for ordinary beams of various sections may be found in any engineering handbook. For a ship's section it is necessary to make a calculation which takes into consideration each continuous longitudinal member which acts efficiently in the vessel's girder.

(b) The moment of a force with reference to any given point is the product of that force by the perpendicular distance from its line of action to the reference point (this is sometimes called statical moment). The algebraic sum of the moments of all the external forces either to the right or left of a given section in a beam is known as the bending moment at that section. Formulæ for bending moments in simple beams for various ordinary distributions of loads are also given in handbooks, but bending moments in a ship must be estimated as described later.

(c) The external loads, or forces, on each side of any cross section of the beam are maintained in equilibrium by the internal stresses generated at that section, see OO_1. It results, accordingly, that the material in the upper portion, AA_1, of the beam experiences a shortening tendency, termed compression, while the material in the lower portion, BB_1, experiences a lengthening tendency, termed tension.

(d) There exists a surface, NN_1, which divides the portion under compression from that under tension. This is termed the neutral surface or axis because it is subjected to neither tension nor compression and consequently is unchanged in length.

(e) The sum of the bending moments produced by the external loads on either side of any section is resisted by the sum of the moments of the internal stresses, both tensile and compressive. This resisting moment equals the bending moment and is expressed by the equation, $\frac{p\,I}{y} = M$.

(f) The resisting shear is the algebraic sum of all the vertical components of the internal stresses at any section of the beam.

(g) The strength of a beam subjected to a bending moment is determined by its section modulus; that is, the ratio of its moment of inertia to the distance of its outermost fiber from its neutral axis, viz., $\frac{I}{y}$.

(h) The neutral axis passes through the center of gravity of the cross section.

(i) The stresses, either tensile or compressive, increase directly with the distance y of a point in the cross section from the neutral axis. Hence, in the case shown, the greatest compressive stress occurs at the upper surface of the beam and the greatest tensile stress at the lower surface.

(j) The resistivity, either tensile or compressive, of a material is usually given in pounds or tons per square inch of cross section; thus, mild steel may be said to have an ultimate or breaking down strength in tension of 60,000 pounds per square inch of cross section. Therefore, mild steel members should be so proportioned that the unit stress to which they are to be subjected under ordinary working conditions will fall well below 60,000 pounds, usually as low as 12,000 or 15,000 pounds.

(k) It is difficult to measure with exactness either the

bending moment or the stresses resulting in a ship at a given time and in a given condition. For the purpose of the strength calculation, then, the ship is assumed to be either on the crest or in the hollow of a trochoidal wave having the same length as that of the ship and a height from trough to crest equal to 1/20 of its length. The bending moment resulting is estimated graphically and the unit stress figured from the formula in question, $p = \frac{M\,y}{I}$, in which M is usually expressed in foot tons, I in square inches times feet squared, y in feet, and p in tons per square inch. The values of p resulting are considered to be relative rather than absolute. That is, if we are dealing with a destroyer design, and the proposed scantlings as laid out on the midship section work out to a value of 8.5 tons per square inch for p, because many other destroyers with similar values of p have been satisfactory in service, we are justified in accepting the scantlings. If the value of p for the conditions assumed

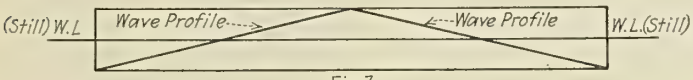
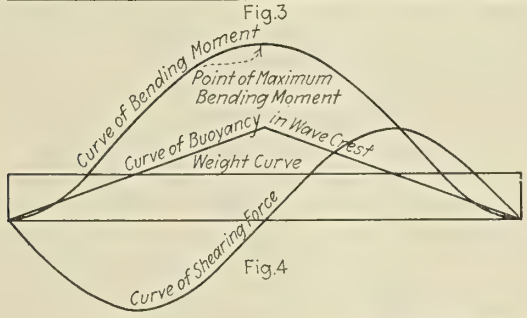


Fig.3


Curve of Bending Moment
Point of Maximum Bending Moment
Curve of Buoyancy in Wave Crest
Weight Curve
Curve of Shearing Force
Fig.4

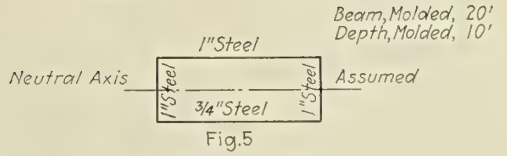


Fig.5

Figs. 3, 4 and 5

worked out 10.5, more material should be used. Such material would probably be best added in stringer, sheer, keel and garboard strakes because farthest from the neutral axis.

(l) In order that vessels may be comparable as described above, the type, arrangement, and condition of loading and character of strength, members must be similar.

Let us illustrate the application of the foregoing by a simple case. Assume—

(a) That we have a scow of rectangular form as shown in Figs. 3 and 5.

(b) That this scow is supported in a wave crest whose profile is triangular in shape and whose length and height (from trough to crest) are the length and depth, respectively, of the scow.

(c) That the material of which the scow is constructed is so distributed as to give her a constant weight per linear foot throughout her entire length, and that this weight is such that the draft in still water is half the depth of the scow.

Then, for the condition shown, the scow being empty—

(a) The weight curve is rectangular, Fig. 4.

(b) The buoyancy in the wave crest is triangular in shape and symmetrical about mid-length.

(c) The difference between the weight and buoyancy curves at any point represents the force acting on the scow's strength girder at that point.

(d) The difference in areas under weight and buoyancy curves on either side of a fixed point is the shear at that point. A curve may be drawn through the values of shear, plotted at close intervals throughout the scow's length. This curve is known as the shearing force, or simply shear curve. The method of its derivation is termed the integration of the load curve, though this curve need not actually be drawn.

(e) The curve of bending moment is obtained by integrating the curve of shears. Its greatest height gives the maximum bending moment, M (see Fig. 4).

(f) The moment of inertia of the vessel's cross section (see Fig. 5) is obtained as follows, the deck being assumed to be without opening and both deck and bottom properly supported so as to work efficiently in longitudinal strength.

ABOVE NEUTRAL AXIS

Item	Area in Square Inches	Lever in Feet	Moment About Neutral Axis	Lever in Feet	Uncorrected Moment Inertia	Correction, $1/12\ A\ l^2$	Corrected Moment of Inertia
½ deck	121	5.04	610	5.04	3080	0	3080
½ side plating.....	60	2.5	150	2.5	375	31	406
	181		760		3455		3486
BELOW NEUTRAL AXIS							
½ bottom plating..	90.6	5.03	456	5.03	2300	6	2300
½ side plating.....	60	2.5	150	2.5	375	31	406
	150.6		606		2675		2706
Summation 331.6			154				6192

The difference in the moments of the material above and below the assumed neutral axis, viz., $760 - 606 = 154$, indicates an error in the assumed location of the neutral axis. Its actual position is $5 + \left(\frac{154}{331.6}\right) = 5.46$ feet above the upper surface of bottom plating. The corrected value of the moment of inertia about the proper neutral axis is $6192 - (.46)^2\ 331.6 = 6121$.

The total moment of inertia for both sides $= 2 \times 6121 = 12242$ square inches by feet squared.

(g) Assume now that the value of the maximum bending moment as read from the curve, Fig. 4, is 12,000 foot tons. The distance y to the most strained fiber in the deck is $5.08 - .46 = 4.62$ and to the most strained fiber in the keel $5.06 + .46 = 5.52$.

Then the maximum tensile stress in the deck,

$$p = \frac{12{,}000 \times 4.62}{12{,}242} = 4.52 \text{ tons per square inch,}$$

and the maximum compressive stress in the keel,

$$p_1 = \frac{12{,}000 \times 5.52}{12{,}242} = 5.42 \text{ tons per square inch.}$$

If now this were a riveted structure, allowance should be made for rivet holes in the tension members. This may be taken as 20 percent for the structure of an ordinary vessel. It is usually assumed that the rivets completely fill the holes so that in the compression members no allowance is made.

Spring Meeting of Naval Architects' Society

A special meeting of the Society of Naval Architects and Marine Engineers will be held in assembly room No. 1 of the Engineering Societies Building, 29 West 39th Street, New York, on Thursday evening, May 26 at 8 P. M. Papers will be read by John F. Metten, chief engineer, The William Cramp & Sons Ship & Engine Building Company, and J. C. Shaw on "The Internal Combustion Engine as Applied to Marine Propulsion," and by Robert Warriner, chief engineer of the Bethlehem Shipbuilding Corporation, Ltd., on "Reduction Gears for Ship Propulsion."

PERSONAL MENTION

NATHANIEL GREEN HERRESHOFF, prominent naval architect and engineer, has been elected an honorary member of the American Society of Mechanical Engineers. The honor will probably be conferred upon Mr. Herreshoff at the spring meeting of the Society.

R. H. M. ROBINSON has been named by the Harriman interests to serve as president of the American Ship & Commerce Corporation, New York, and will hold the same position for the subsidiary navigation company. Mr. Robinson has been associated with W. A. Harriman for several years and has been president of the Merchant Shipbuilding Corporation at the Chester plant and agent for the Emergency Fleet Corporation at the Bristol yard.

CAPTAIN WILLIAM P. DURTNALL, consulting engineer, was born at Herne Bay, Kent, 1872. He received his education in the public schools of this place and later completed his training in the shops of the Maxim Electric Company, London. Until 1905 he held various positions in connection with the operation and maintenance of mechanical and electrical plants. At this time he commenced a thorough study of naval architecture and marine engineering and soon after developed the system of electrical power transmission for ships, known as the thermo electric ship propulsion system. The principles of this system have been applied to motor omnibus transmission and to railway locomotives. In 1907 he was elected a member of the Institution of Automobile Engineers, and in 1908 a member of the Institution of Marine Engineers. In 1912 he was elected a member of the North East Coast Institution of Engineers and Shipbuilders. In this year he carried out a complete series of tests on the auxiliary machinery of cargo vessels in Italy and demonstrated the possibility of adapting the internal combustion-electric drive to ships. He spent part of this period in developing internal combustion engines in connection with locomotive practice. During the early part of the war he was engaged in the design and erection of a gun-cotton plant near London, and later was commissioned as a lieutenant in the navy and assigned to H. M. S. *Vernon,* on which ship he conducted tests on signalling apparatus. Later in the war he served with the Royal Air Force as staff captain, carrying out tests on prime movers. Since June, 1920, he has been on the consulting staff of Messrs. R. & W. Hawthorne, Leslie & Company, Ltd., and has been engaged in the development of his various inventions in connection with hydro-electric and internal combustion locomotives.

Capt. Wm. P. Durtnall

FREDERICK W. BAKER, former assistant superintendent of construction at the Bath Iron Works, Bath, Me., has been appointed superintendent of construction to succeed the late John McInnes, who died January 22. Mr. Baker is a graduate of the Massachusetts Institute of Technology and studied naval architecture at the University of Glasgow; he was formerly connected with William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., with the New York Shipbuilding Corporation, Camden, N. J., and the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

OBITUARY

LESTER GRAY FRENCH, for thirteen years editor of *Mechanical Engineering,* the journal of the *American Society of Mechanical Engineers,* died on April 18, at the French Hospital, New York City, from septic poisoning following an operation. Mr. French was a graduate of the Massachusetts Institute of Technology. From 1897 until 1906, he was editor-in-chief of *Machinery.* In 1908 he became editor of the publications of the *American Society of Mechanical Engineers,* and in recent years acted also as assistant secretary of the society.

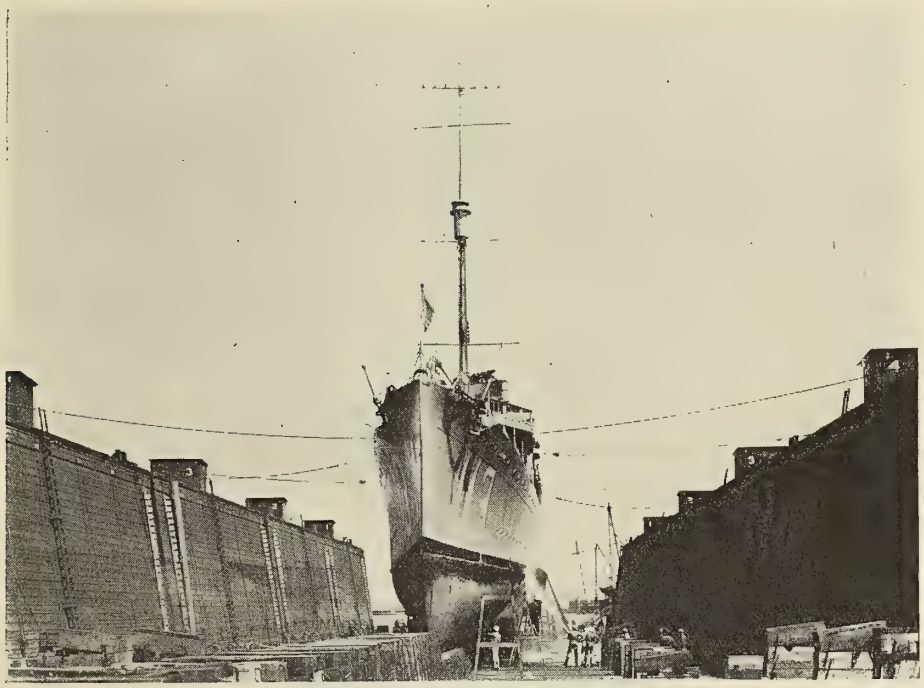
WILLIAM DUNDERDALE FORBES, well known in this country and abroad as a consulting engineer, inventor, manufacturer and writer on engineering subjects, died at his home in New Orleans, La., on February 17. Born in Perth Amboy, N. J., Mr. Forbes was educated abroad, and while a student in France served in the Franco-Prussian war as a franc-tireur in the French Army. Before returning to this country he worked with the famous gunsmiths of Switzerland and for a time was on the editorial staff of *Engineering* of London. Upon returning from Europe in 1872, Mr. Forbes began his professional career with the Delamater Iron Works, at that time located on West 11th street, New York City. Following this, he became engineer of the Gould Sprinkler Company, 237 Broadway, New York. He then spent two years in Kempton, Jamaica, as operating engineer for the Watson Sugar Plantation Company, and in 1878 was appointed by Governor Palmer of Colorado as chief engineer of the Gunnison Division of the Denver and Rio Grande Railroad Company with headquarters at Gunnison, Colo. Returning East after two years, be became superintendent of the Eaton, Cole & Burnham Manufacturing Comany, Bridgeport, Conn. At this time he invented the Forbes patent die stock and, forming a partnership with Roderick P. Curtis of Bridgeport, took up the manufacture of this specialty, selling his interest to the Curtis family in 1888. As Mr. Forbes was chiefly interested in the development and manufacture of high speed marine engines and other marine machinery, he came to New York and, entering into partnership with the late Col. E. A. Stevens, established the W. D. Forbes Company in Hoboken, N. J., for the manufacture of marine engines and ice machines for the Government and for owners of private yachts. For sixteen years this plant, known to many as the "gun shop" on account of Mr. Forbes' interest in the development of rapid fire machine guns, was in active operation in Hoboken, after which it was moved to New London, Conn., where later, owing to unfavorable business conditions, the business was discontinued. Seven years ago, Mr. Forbes was stricken with brain fever, resulting in total blindness. During the last years of his life, although deprived of sight, Mr. Forbes continued his professional activities in the design and development of mechanical devices, including a successful automatic rifle, and in contributing to the engineering press, many of his articles appearing in MARINE ENGINEERING. For many years Mr. Forbes was an active member of the Society of Naval Architects and Marine Engineers, serving several terms as a member of the Council. He was also a member of the Engineers' Club of New York. Apart from his professional career, his interests were many and varied. For nine years he was a member of the Board of Education of New Jersey, and for several years was in charge of the colored school at Bordentown, N. J. He is survived by a wife, a daughter and a son, who is State Forester of Louisiana. To those who were privileged to know and work with Mr. Forbes, his life will always be an inspiration, not only because of his ability and achievements, but also because of the brave and generous spirit which marked his cheerful and helpful association with his fellow men.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

RECONDITIONING CONTRACTS VALUED AT MILLIONS WERE PLACED DURING PAST MONTH

Los Angeles Shipbuilding & Dry Dock Company Wins Notable Government Award to Repair Over Ships—Eastern Yards Get Big Contracts—Employment For Many



The Race Horse of the Ocean. The U. S. Destroyer *Rathburne* in the Dry Dock of the Los Angeles Shipbuilding & Dry Dock Company

Ship reconditioning contracts involving millions of dollars and which will afford employment to many hundreds of workmen of innumerable trades—these are two of the principal outstanding features of the situation in American shipyards during the past month. Although some yards are idle, latest reports received by MARINE ENGINEERING indicate a pronounced improvement over the month previous.

Outside of New York probably the most interesting contract is that drawn and approved at Washington, D. C., by the terms of which the destroyers and other Government craft of the Pacific Fleet, approximating over 100 vessels, are to be sent as need arises to the plant of the Los Angeles Shipbuilding & Dry Dock Company, in the west basin of Los Angeles harbor, for dry docking and repairs. This contract is taken to mean a steady and substantial outlay by the Navy Department, which in turn reflects credit upon the shipyard and much brighter prospects for its employes and in this connection is believed to be of far-reaching import to the harbor and city and the entire community.

In February, last, Rear Admiral Welles, Captain T. S. Jewett and Captain Chauncey Shackford made a very thorough inspection of the dry docking and repair facilities of the Los Angeles Shipbuilding & Dry Dock Company's plant, at the close of which Admiral Welles spoke very highly of the scope of facilities and the complete equipment which the local yard provided, saying in fact, "I am greatly impressed with the shipbuilding and dry docking facilities here. I had no idea that there was such a shipyard here which could build six large steamers at one time. I find the facilities of dry docking at the Los Angeles Shipbuilding & Dry Dock Company excellent and fully meeting the requirements."

Following the Admiral's inspection of the facilities of the yard, a further test was made by the department sending first a mine layer, the U. S. S. *Gannet,* for dry docking, hull attention and minor repairs and later the destroyer *Rathburne* for similar treatment. The eminently satisfactory results of these practical tests have apparently presented the final argument for the signing of the definite contract between the Navy Department and the officials of the shipyard under the terms of which a steady succession of destroyers and other Government craft will be sent to its plant for such treatment as they require. It is understood that because of the congested conditions at the Mare Island Navy Yard, a large number of the vessels of the Pacific Fleet have been unable to receive the dry docking and repair attention required. In the majority of instances, they are expected to remain on the dry dock about 48 hours each for thorough hull cleaning and painting. Some, however, will require a longer time for other repairs to be carried out.

In addition to the upwards of 100 destroyers of the Pacific Fleet under Admiral Welles' command based on Los Angeles and San Diego, there are a number of Government colliers, mine layers, tugs and several cruisers for which the dry docking and other repair facilities of the Los Angeles Shipbuilding & Dry Dock Company are fully adequate.

Contracts of note placed with yards in and around New York during April include the *George Washington,* at the Tietjen & Lang yard; the *America,* Morse Dry Dock & Repair Company; the *Momus,* the Tebo Yacht & Basin Company; the *Coppename,* at the W. & A. Fletcher Company, this ship being the third of three similar jobs.

It is also reported that David Rodgers, of Seattle, Wash., who became prominent as a shipbuilder when Seattle was making records during the war, has purchased a floating dry dock and equipment of the old Seattle Dry Dock Company for the establishment of a large marine repair plant.

Rinek Cordage Company Gets Shipping Board Contract

The Rinek Cordage Company, Easton, Pa., were the successful bidders recently for the rope requirements for the United States Shipping Board, beginning March 1st. The company has opened a warehouse and permanent offices in New York City, the offices being at 149 Broadway. John W. Miller is sales manager.

"Imperator's" Name Changed

The Cunard Steamship Company notify that, in consequence of their desire to bring the name into harmony with other vessels of the company's fleet, they have applied to the Board of Trade for permission to change the name of the *Imperator* to *Berengaria.* They have also asked permission to have Liverpool substituted for London as the vessel's port of registry.

NEW FIREBOAT

Commissioner Whalen Drives First Rivet in $222,000 Job

On March 31st the keel was laid for a new steel fireboat which the Standard Shipbuilding Corporation, of Shooters Island, New York, is building for the fire department of the City of New York. The first rivet in the keel of the new fire fighter was driven by Grover A. Whalen, Commissioner of Plant and Structures of the City of New York.

The new fireboat, which will cost $222,000, will be similar to the *William J. Gaynor*, 121 feet long, 27 feet beam, 14 feet 9 inches depth, and will have a speed of 12 knots. This new fire fighter will be equipped with the latest fire fighting appliances, and, when completed, will supplant the *William J. Gaynor* at Brooklyn, while the latter will be transferred to Staten Island to protect the new pier developments.

March Construction

The Bureau of Navigation, Department of Commerce, Washington, D. C., reports 83 sailing, steam, gas and unrigged vessels of 145,852 gross tons built in the United States and officially numbered during the month of March, 1921. Of the total, 8 vessels of 5,029 gross tons were for the United States Shipping Board and 10 of these ships were steel tankers. Three vessels with a total of 9,012 tons were built in the United States for foreign owners during the month of February and 20 vessels of 8,375 gross tons were reported as transferred to foreign flags during the month of March.

Civil Service Examinations

Applications are being received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., to fill vacancies in the commissioned grade of Assistant Civil Engineer, Corps of Civil Engineers, U. S. Navy, with rank of Lieutenant (junior grade). The pay and allowances at entrance are approximately $3,200 per annum, with increase up to $9,600, depending upon promotions in rank and length of service. The candidate must be an American citizen between the ages of 22 and 30 years on August 1, 1921; must have received a degree in engineering; must have had not less than 20 months practical professional experience since graduation, and must be of good moral character and repute. The preliminary examination to determine general fitness will be based on papers submitted by the candidates, reaching the Board on or before May 16, 1921, covering college record, testimonials, references and professional experience.

The United States Civil Service Commission has announced examinations to be held on May 25 and 26, and July 6 and 7 to fill a number of existing vacancies in positions of junior engineer and deck officer, United States Coast and Geodetic Survey. The entrance salary is $2,000 a year.

TANKER LAUNCHED

Union Shipbuilding Company Completes Another Oil Carrier

The bulk oil tanker *Gulfprince*, latest addition to the fleet of the Gulf Refining Company, was launched April 2 at the yard of Union Shipbuilding Co., Curtis Bay, Baltimore, Md. A duplicate, the *Gulfking*, was launched during December. The big tanker was practically complete when launched, boilers and engines having been installed while on the ways.

They are single screw ships 436 feet 1 inch length overall, 419 feet 3 inches length between perpendicular, 56 feet 3 inches beam, 33 feet 4 inches depth to upper deck, and 9,970 tons deadweight. The vessels are of the shelter deck type, machinery and quarters aft, bridge-house amidships, with two pole masts. They are built to Lloyds, 100 A-1, Special Survey on the longitudinal system of framing.

The propelling unit consists of a triple expansion engine 27 inches by 45 inches by 75 inches and 51 inches stroke, which gives a loaded sea-speed of 11½ knots. Steam at 195 pounds working pressure is generated by three single-ended Scotch boilers, 15 feet 10 inches diameter by 11 feet 4 inches long, having three 46 inches Morrison corrugated furnaces. The Howden System of forced draft is used.

New Pump Foundry

It is announced at Montreal that Messrs. G. & J. Weir (Canada), Ltd., are starting on the construction of a foundry at Ville La Salle, near Montreal, for the manufacture of Weir pumps of all kinds, oil fuel pressure pumps and oil fuel transfer pumps, service pumps for ballast, fresh water and general purposes, turbine-driven circulating pumps, dual air pumps, direct-acting feed pumps, turbo feed pumps, etc. It is proposed to start with a staff of about fifty molders and the necessary complement of other workers, with the expectation that the industry will rapidly grow with the development of the port.

SHIPS UNDER CONSTRUCTION IN VARIOUS YARDS FOR UNITED STATES NAVY

Vessels under construction for the United States Navy, their degree of completion and the probable dates of completion as reported March 31, 1921, are announced by the Bureau of Construction and Repair, Washington, D. C., as follows:

Type Number and Name	Contractor	% of Completion Apr. 1, 1921 Total	% of Completion Mar. 1, 1921 Total	Probable Date of Com'tion
BATTLESHIPS (BB)				
44 *California*	Mare Island Navy Yard...	96.1	95.8	10- 1-21
45 *Colorado**	New York S. B. Corp.....	69.3	68.	6- -22
46 *Maryland*	New. News S.B. & D.D. Co.	96.8	95.	7- -21
47 *Washington*	New York S. B. Corp.....	61.2	59.5	4- -23
48 *West Virginia*	New. News S.B. & D.D. Co.	49.5	47.	10- -22
49 *South Dakota*	New York Navy Yard.....	26.7	26.	
50 *Indiana*	New York Navy Yard.....	23.1	21.4	
51 *Montana*	Mare Island Navy Yard...	18.	17.4	
52 *North Carolina*	Norfolk Navy Yard.....	27.4	24.1	
53 *Iowa*	New. News S.B. & D.D. Co.	16.1	14.1	
54 *Massachusetts*	Beth. S.B. Crp.(Fore River)	2.5	2.	11- -22
BATTLE CRUISERS (CC)				
1 *Lexington*	Beth. S.B. Crp. (Fore River)	13.8	10.6	9- -23
2 *Constellation*	New. News S.B. & D.D. Co.	7.9	6.5	
3 *Saratoga*	New York S. B. Corp.....	18.1	16.	12- -23
4 *Ranger*	New. News S.B. & D.D. Co.	1.2	1.1	
5 *Constitution*	Philadelphia Navy Yard...	4.3	3.	
6 *United States*	Philadelphia Navy Yard...	4.3	3.	
SCOUT CRUISERS (LIGHT CRUISERS, CL)				
4 *Omaha*	Todd D. D. & Const. Corp.	90.	88.4	12- -21
5 *Milwaukee*	Todd D. D. & Const. Corp.	84.7	81.6	3- -22
6 *Cincinnati*	Todd D. D. & Const. Corp.	80.6	73.4	5- -22
7 *Raleigh*	Beth. S.B. Crp. (Fore River)	51.4	47.5	3- -22
8 *Detroit*	Beth. S.B. Crp. (Fore River)	51.2	47.4	4- -22
9 *Richmond*	Wm. Cramp & Sons Co....	62.	60.	2-15-22
10 *Concord*	Wm. Cramp & Sons Co....	60.	59.	4- 1-22
11 *Trenton*	Wm. Cramp & Sons Co....	41.	40.	6- 1-22
12 *Marblehead*	Wm. Cramp & Sons Co....	39.	38.	7- 1-22
13 *Memphis*	Wm. Cramp & Sons Co....	32.	31.	9- 1-22
AUXILIARIES				
Fuel ship No. 18, *Pecos* (oiler AO 6)	Boston Navy Yard.....	75.5	67.4	11- -21
†Amm. ship No. 2, *Nitro* (AE 2)....	Puget Sound Navy Yard...	99.9	99.9	4-16-21
Repair ship No. 1, *Medusa* (AR 1)..	Puget Sound Navy Yard...	58.	55.5	2-28-22
Dest. tender No. 3, *Dobbin* (AD 3)..	Philadelphia Navy Yard...	52.3	50.3	3- 1-22
Dest. tender No. 4, *Whitney* (AD 4).	Boston Navy Yard.....	19.5	17.6	10- -22
Sub. tender No. 3, *Holland* (AS 3).	Puget Sound Navy Yard...	14.	9.5	
Aircraft tender, *Wright* (AZ 1)....	Tietjen & Lang.....	57.	48.	7-15-21
DESTROYERS				
135 *Tillman*	Charleston Navy Yard.....	99.	98.9	4-30-21
230 *Paul Jones*	Wm. Cramp & Sons Co....	98.	95.	4-18-21
249 *Hopkins*	New York S. B. Corp.....		99.	‡3-21-21
250 *Lawrence*	New York S. B. Corp.....	99.7	97.3	4-15-21
322 *Mervine*	Beth. S. B. Crp. (San Fran.)		100.	‡3- 1-21
323 *Chase*	Beth. S. B. Crp. (San Fran.)		95.1	‡3-10-21
324 *Robert Smith*	Beth. S. B. Crp. (San Fran.)		90.2	‡3-17-21
325 *Mullany*	Beth. S. B. Crp. (San Fran.)		86.9	‡3-29-21
326 *Coghlan*	Beth. S. B. Crp. (San Fran.)		82.9	‡3-31-21
327 *Preston*	Beth. S. B. Crp. (San Fran.)	96.2	80.	4-13-21
328 *Lamson*	Beth. S. B. Crp. (San Fran.)	90.6	80.7	4-18-21
330 *Hull*	Beth. S. B. Crp. (San Fran.)	86.6	78.3	4-20-21
331 *MacDonough*	Beth. S. B. Crp. (San Fran.)	83.2	78.3	4-27-21
332 *Farenholt*	Beth. S. B. Crp. (San Fran.)	78.2	74.1	5- 4-21
333 *Sumner*	Beth. S. B. Crp. (San Fran.)	79.5	76.6	5-10-21
334 *Corry*	Beth. S. B. Crp. (San Fran.)	73.	60.8	5-20-21
335 *Melvin*	Beth. S. B. Crp. (San Fran.)	63.9	55.4	5-31-21
338 *Wasmuth*	Mare Island Navy Yard...	97.3	97.1	
339 *Trevor*	Mare Island Navy Yard...	94.4	94.2	
340 *Perry*	Mare Island Navy Yard...	58.1	56.7	
341 *Decatur*	Mare Island Navy Yard...	54.2	52.8	

Destroyers authorized but not under construction or contract: (12) Nos 348 to 359, inclusive.

(Contined on next page)

PATROL VESSELS

Gunboat No. 22, *Tulsa* (PG 22)	Charleston Navy Yard	59.8	55.		12-30-21

Authorized but not under construction or contract: (1) Transport No. 2.

SUBMARINES

115 S-10	Portsmouth, N. H., Navy Yd	90.3	88.7		
116 S-11	Portsmouth, N. H., Navy Yd	85.7	84.6		
117 S-12	Portsmouth, N. H., Navy Yd	75.4	74.4		
118 S-13	Portsmouth, N. H., Navy Yd	65.3	59.2		
123 S-18	Elec. Boat Co. (Quincy)	97.	97.		
124 S-19	Elec. Boat Co. (Quincy)	96.5	96.5		
125 S-20	Elec. Boat Co. (Quincy)	98.5	98.5		
126 S-21	Elec. Boat Co. (Quincy)	94.9	94.9		
127 S-22	Elec. Boat Co. (Quincy)	95.8	95.8		
128 S-23	Elec. Boat Co. (Quincy)	94.	94.		
129 S-24	Elec. Boat Co. (Quincy)	93.	92.1		
130 S-25	Elec. Boat Co. (Quincy)	93.5	93.		
131 S-26	Elec. Boat Co. (Quincy)	92.4	91.4		
132 S-27	Elec. Boat Co. (Quincy)	91.	89.7		
133 S-28	Elec. Boat Co. (Quincy)	91.6	89.7		
134 S-29	Elec. Boat Co. (Quincy)	90.5	88.8		
136 S-31	Elec. Boat Co. (San Fran.)	97.5	97.5		
137 S-32	Elec. Boat Co. (San Fran.)	95.1	94.4		
138 S-33	Elec. Boat Co. (San Fran.)	99.2	99.2		
139 S-34	Elec. Boat Co. (San Fran.)	93.8	92.7		
140 S-35	Elec. Boat Co. (San Fran.)	92.9	87.5		
141 S-36	Elec. Boat Co. (San Fran.)	83.7	83.4		
142 S-37	Elec. Boat Co. (San Fran.)	79.9	76.8		
143 S-38	Elec. Boat Co. (San Fran.)	71.4	71.1		
144 S-39	Elec. Boat Co. (San Fran.)	67.2	67.2		
145 S-40	Elec. Boat Co. (San Fran.)	71.6	71.6		
146 S-41	Elec. Boat Co. (San Fran.)	72.9	71.7		
153 S-42	Elec. Boat Co. (Quincy)	56.8	51.7	1-	-22
154 S-43	Elec. Boat Co. (Quincy)	56.9	52.8	1-	-22
155 S-44	Elec. Boat Co. (Quincy)	54.9	51.	2-	-22
156 S-45	Elec. Boat Co. (Quincy)	56.2	52.2	3-	-22
157 S-46	Elec. Boat Co. (Quincy)	54.4	50.8	4-	-22
158 S-47	Elec. Boat Co. (Quincy)	54.4	50.8	4-	-22
159 S-48	Lake T. B. Co. (Bridgeport)	85.4	81.5	8-	1-21
160 S-49	Lake T. B. Co. (Bridgeport)	76.8	69.3	8-	1-21
161 S-50	Lake T. B. Co. (Bridgeport)	67.8	63.2	9-	1-21
162 S-51	Lake T. B. Co. (Bridgeport)	64.7	62.6	10-	1-21

FLEET SUBMARINES (SF)

60 T-2 (SF 2)	Elec. Boat Co. (Quincy)	98.7	98.7	5-	1-21
163 V-1 (SF 4)	Portsmouth, N. H., Navy Yd				
164 V-2 (SF 5)	Portsmouth, N. H., Navy Yd				
165 V-3 (SF 6)	Portsmouth, N. H., Navy Yd				

NOTE: Submarines authorized but not under construction or contract: Fleet submarines (6), Nos. 166 to 171; Neff submarine (1), No. 108.

* Battleship No. 45—launched 3-22-21.
† Ammunition ship No. 2—commissioned 4-1-21.
‡ Delivered.

CHESTER, PA., SHIPYARD TO ENTER GENERAL ENGINEERING AND CONSTRUCTION FIELDS

Merchant Shipbuilding Corporation Makes Announcement of Expansion Into New Lines Which May Provide Employment for Hundreds of Additional Men

The Merchant Shipbuilding Corporation, which operates a modern $6,500,000 plant covering fifty acres at Chester, Pa., has decided to immediately branch out in general engineering lines, embracing steel construction in general, manufacturing and power plant equipment, machinery and machine work, railroad equipment and material, and plate shop work. This will be in addition to the general shipbuilding business now conducted, including ship conversion and repair work.

The yard is adequately equipped for extensive work along these lines, especially in shipbuilding and kindred work. Ships up to 15,000 deadweight ton capacity are now being built. Every facility is available for the conversion of previously built steamships to Diesel motor ships, electric driven or geared turbine drive.

It is also stated from an authoritative source that this corporation will be one of the few in America to be licensed to build Diesel engines. This branch alone would give employment to hundreds of additional men in the Chester Yard.

These new lines recently decided upon by the directors of the Merchant Shipbuilding Corporation hark back to the days when the yard of that pioneer in American shipbuilding, John Roach, was known as the Delaware River Iron Shipbuilding & Engineering Works.

In keeping with the tradition of the Chester Shipyard, which was founded in 1859, the present management is determined to round out its activities and has chosen the above mentioned lines to increase its production capacity.

This expansion is in keeping with the progressive methods of the Harriman interests which control the Chester industry. Already a large organization of specialists in the various new lines of endeavor have been assembled, giving the corporation enviable facilities for handling structural and mechanical engineering projects, as well as marine engineering.

When asked concerning the future of shipyards, J. J. Ackerson, vice-president of the Merchant Shipbuilding Corporation, who is in charge of operations at Chester said:

"The general depression in shipping, and, therefore, in shipbuilding, has forced practically all the shipyards originating during the war to cease all activities, and a great majority of the old yards have suffered a setback from which it will take another period of prosperity to recuperate.

"The consequences of these conditions in regard to unemployment are no longer something which is left to the imagination to realize—they are cold facts."

The general public may be prone to believe that a step such as is now being taken by the Merchant Shipbuilding Corporation, is inspired mainly out of consideration for the money interests behind it. In many if not in most cases, however, it would be infinitely cheaper and easier to close down a plant of this nature until such time as conditions again warrant its reopening, than to enter strange fields during a period of strong competition and general depression. Even with the extensive facilities this yard has at its disposal, the expenditures for remodeling and reorganizing a 100 percent shipbuilding yard into a general manufacturing and industrial concern must necessarily be considerable.

Mr. Ackerson was asked whether or not his company would be able to operate the plant under its new conditions on a comfortable basis, therefore assuring the permanancy of the new ventures. This question brought forth an emphatic "Yes." Mr. Ackerson continued by saying:

"We will do our best to work at a small profit. Any other principle would be unsound from a business standpoint, apart from the fact that we would lay ourselves open to attack for being unfair competitors. However, the small profit which we will be able to add in competition as keen as it is at present will by no means provide an adequate return for the capital invested in the plant, but Mr. Harriman considers it incumbent upon everybody who has means enough for weathering the storm to do their utmost to keep the industrial plants going, both for the sake of American industry and enterprise generally."

MARINE EXHIBIT

New York City to Have First Annual Exhibit of New Association

The first meeting of the executive committee of the newly organized Marine Equipment Association of America was held in the office of Colonel Edward A. Simmons, president, on April 12. It was decided to hold the first annual exhibit in New York City in November of this year, during the week in which the Society of Naval Architects and Marine Engineers will hold its annual meeting.

The following were appointed chairmen of the committees named: W. M. Wampler, Coen Company, exhibits; Frank Hatch, Shepard Electric Crane & Hoist Company, entertainment; J. D. Sarles, Pyle-National Company, enrollment, and W. M. McFarland, Babcock & Wilcox Company, finance. In addition M. L. Katzenstein, of the Worthington Pump & Machinery Corporation, was designated as chairman of a special committee to act in connection with one which it is expected the Society of Naval Architects and Marine Engineers will appoint for joint action in planning activities during the week of the marine show.

CANADIAN CONSTRUCTION

329 Vessels in 1920 With 100,000 Deadweight Tons Coming

Complete returns for 1920 show that the Canadian shipbuilding industry turned out a great deal more tonnage than seemed probable at the end of the year. Statistics just issued by the Department of Marine and Fisheries placed the total gross tonnage built at 204,635 tons, representing 351 vessels of one kind or another.

The vessels built and registered in Canada during 1920 numbered 329, classified as follows: wooden sailing vessels 121, wooden steam vessels 53, wooden gas vessels 119, metal vessels—steam 35, gas 1. In point of gross tonnage the steam metal vessels led with 120,127 tons, followed by wooden sailing vessels, 22,758 tons; steam wooden vessels, 12,829 tons; gas wooden vessels, 3,495 tons, gas metal vessels, 116 tons—total 159,325 gross tons.

The vessels built but not registered in Canada during the year were 22 in number, 13 of them being wooden steam vessels, 9 steel steam vessels and one wooden sailing vessel. The gross tonnage was: steel steam vessels, 31,135 tons; wooden steam vessels, 13,829 tons; wooden sailing vessels, 348 tons.

British Columbia with 138 to her credit led the provinces in the number of vessels turned out, but Quebec, though she is credited with only 96 vessels, led in gross tonnage with 103,339 tons, as compared with British Columbia's 66,561 tons. These figures do not, however, accurately indicate the tonnage actually turned out in these respective provinces, the vessels for the Canadian Mercantile Marine, a number of which were built in British Columbia, having been registered in Quebec, and thus appear in the tonnage credited to that province. Nova Scotia turned out 90 vessels, almost all small. Ontario is credited with but 17 vessels, showing how the industry has fallen off in that province. New Brunswick turned out 5 vessels, Prince Edward Island 4, and Saskatchewan 1. Alberta and Manitoba do not appear at all in these returns.

The prospects for the present year are admittedly not as good. There are, however, fifteen vessels for the Mercantile Marine still to be delivered, these representing about 100,000 tons deadweight. Some yards are also building vessels on foreign account.

At the 31st of December, 1920, there were 7,906 vessels of all kinds on the Canadian register, of which 3,623 were sailing and 4,281 operated by steam. The gross tonnage of sailing vessels was 505,630, and of steam, 1,105,010 tons, making a total tonnage of 1,610,640 gross, and 1,151,880 net.

Port Authorities' Convention

The tenth annual convention of the American Association of Port Authorities is to be held in Seattle, October 11, 12, 13 and 14. The association comprises all of the organized ports in the United States and Canada. Port authorities are planning to entertain 1,000 delegates.

New Fruit Line in Prospect

Establishment of a line of fruit cargo steamers between Seattle and European ports is in prospect. Nine 15,000-ton steamships, each equipped with 3,000 tons of refrigerated space, will be placed on this route by the Royal Mail Steam Packet Company, according to the information. The fleet of steamers is said to be nearing completion in the Clyde shipyards and the first is scheduled to leave England in May.

Steamer Kathyrn Luckenbach Gets Record Service at Los Angeles

As an example of service particularly appreciated by ship owners, a contract completed by the Los Angeles Shipbuilding & Dry Dock Company on the *Kathryn Luckenbach,* of the Luckenbach Steamship Company, April 2, is worthy of note. The big freighter, arriving with cargo at San Pedro, required some boiler and other repairs and, thanks to the enterprise, equipment and resources of the Los Angeles Shipbuilding & Dry Dock Company, she had 132 tubes replaced in her four boilers, her steering engine and tiller motor repaired, two main brasses bored and rebabbitted and other minor repairs effected during the 48 hours which she lay discharging cargo at her wharf at the Outer Harbor, San Pedro.

Not only was this work done without the ship losing an hour of running time, but by attending to one boiler at a time the shipbuilding company enabled the ship to keep up steam needed for unloading, thus not delaying her at the dock even longer than she would ordinarily have stayed. Shipping men on the San Pedro waterfront claim that it is this type of efficient and prompt service which will prove a big factor in building the business of the port of Los Angeles.

Ship Damaged By Fire

A fire broke out recently on board the 11,000 ton *Grampian,* of the C. P. O. S. line. This vessel has been in the Antwerp Docks undergoing repairs for several weeks. Owing to the vessel being light and consequently very high, difficulty was experienced in extinguishing the fire. The ship is gutted from the master's cabin to the No. 3 hold and the damage is estimated to amount to several million pounds.

BUSINESS NOTES

The Keller Pneumatic Tool Company announces the removal of its Chicago branch to larger and more up-to-date salesrooms and service station. After May 1st this branch will be located on the main floor in the Transportation Building, 624 South Dearborn Street, Chicago, where a complete stock of tools and parts will be maintained. J. C. Campbell is district manager.

Announcement is made of the changing of the general sales offices of the Pollak Steel Company of Cincinnati from 2850-2860 Equitable Building, New York City, to 3115-3116-3117 Equitable Building.

The Engineering Business Exchange, 30 Church Street, New York City, announces the opening of a southeastern branch with Marshall Leighton, consulting engineering of Washington, D. C., as director. The southeastern branch has offices in the McLachlen Building, Washington, D. C., and it will co-operate with the main office in New York City in the conduct of business. Mr. Leighton will have special charge of the territory from Maryland to Alabama inclusive.

The Conveyors Corporation of America, Chicago and New York, announce the appointment of Robert B. M. Wilson as sales engineer of the Chicago district. With him will be associated, as an assistant, E. M. Wolfe. Headquarters will be maintained in the corporation's main office at 326 West Madison Street.

The Airco organization, Air Reduction Sales Company, large manufacturers of Airco oxygen, Airco acetylene and Airco welding and cutting apparatus, will move its executive offices on May 1st from 120 Broadway and 160 Fifth Avenue to 342 Madison Avenue, New York City. Coincident with the announcement of the general office change is another to the effect that the New York district office of Airco after May 1st will be located at the Airco factory, 191 Pacific Avenue, Jersey City, N. J. All correspondence and other communications heretofore directed to the Airco district office at 160 Fifth Avenue, New York, should in the future be sent to 191 Pacific Avenue, Jersey City, N. J.

The E. Horton & Son Company, Windsor Locks, Conn., has purchased the chuck business of the American Company of Hartford, Conn. The American Company has specialized in the three-jaw geared drill chuck known as the Ellison chuck. In adding this line of Ellison drill chucks to its present equipment the Horton Company is enabled to manufacture a drill chuck of every standard including the two-jaw and three-jaw geared chuck and the hand operated self-tightening chuck, making in addition to these a complete line of lathe chucks and face plate jaws.

The International Pulverized Fuel Corporation announces the location of their general office in the National City Building, 17 East 42nd Street, New York City.

Announcement is made by the Superheater Company that on May 1st its general offices will be moved from 30 Church Street to 17 East 42nd Street, New York City.

The Hooven, Owens, Rentschler Company, Hamilton, Ohio, announce the appointment of Mr. Ross L. Fryer, Albee building, Washington, D. C., as their agent in the District of Columbia territory.

Gerard H. Rittenhouse, of Philadelphia, Pa., has severed his connection with United Cork Company, of New York.

Announcement is made that H. M. Hedges has rejoined the Moore & McCormack Company's India service, and that M. S. Ulman is on the staff of the Atlantic, Gulf & Mediterranean Steamship Corporation, New York.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Tanker Repairs, Mobile, Ala.—The Gulf Refining Company's steam tanker Winifred will be put into drydock at the Alabama Dry Dock & Shipbuilding Company's plant for repairs.

Steamships Wanted—A company in Australia is reported to be desirous of receiving quotations on six steamships of from 4,000 to 5,000 gross tons, of a type suitable for Australian overseas and coastwise general cargo service.

To Lay Keels, Oakland, Cal.—Five vessels are on the ways of the Union Construction Company and preparations are being made to lay keels for two cutters and an ocean-going tug for the Treasury Department.

Schooner Construction, Victoria, B. C.—The Cholberg Shipyard is reported as actively proceeding with the construction of three of the four wooden schooners being built as lumber carriers with the aid of the Dominion Government.

Barges, Kearny, N. J.—The Federal Shipbuilding Company has just laid the keel for the first of six 350-ton coal barges for the War Department. These barges are being fabricated by the American Bridge Company, Pittsburgh, Pa., and assembled by the Federal Yard.

Car Floats, Newark, N. J.—The Federal Shipbuilding Company has a contract for the construction of three car floats of 1,000 tons each for the New York Dock Company. It is expected that these floats will be ready for delivery next September.

Barges, Pensacola, Fla.—It is reported that the Pensacola Shipbuilding Company has secured contracts for building some additional barges. Although no details have been made public, it is stated that material for about twenty new barges is now being assembled.

Yacht Contract Awarded, Vancouver, B. C.—A contract for building the hull of the Royal Vancouver Yacht Club's Lipton Cup challenger has been awarded to Hoffar Brothers, and work has been started on the boat at the Coal Harbor plant.

Stern-Wheel Boat, Memphis, Tenn.—The Mississippi River Commission, First and Second Districts, Custom House, Memphis, has let a contract for furnishing the stern-wheel steamboat Luther D. Griffith to J. Eichleary, Jr., Twentieth and Wharton streets, Pittsburgh, Pa., at a cost of $41,414.

Car Float, Vancouver, B. C.—It is reported that the Harbor Commissioners are asking tenders for the construction of a car float for operation between Vancouver and North Vancouver. It is said that the float, which is to be of wood, and the building of a slip on the north shore, will cost about $200,000.

Barges, New Orleans, La.—The Doullut & Williams Shipbuilding Company will lay keels for the first two of six 9,000-barrel oil barges of steel construction, which will be followed by the laying of other keels as soon as the material can be assembled for erection. Work at the outfitting dock is being pushed with a vim.

Repairing Steamer, Shooters Island, N. Y.—Contract for installation of a Scotch boiler and miscellaneous hull and engine repairs to the steamer Western Union has been awarded to the Standard Shipbuilding Company, Shooters Island, N. Y., on their bid of $18,000 and seventy days. The work is already under way.

Ship to be Repaired, Brooklyn, N. Y.—The Morse Dry Dock & Repair Company has been awarded the contract for repairs to the tank ship, L. J. Drake, of the Standard Oil Company of New Jersey on a bid of $24,000. The work consists of repairs to the turbines, the cargo oil system and oil heating system.

Reconditioning Fireboat, Brooklyn, N. Y.—A contract for reconditioning the fireboat The New Yorker has been awarded by the New York Fire Department to the Tebo Yacht Basin Company on a bid of $13,544. The work is to be done in forty days, and involves considerable minor repairs to the vessel, especially the renewal of a large number of frames.

Electric Drive Installation, Brooklyn, N. Y.—A contract for the installation of electric drive equipment in the steamship Independence has been awarded by the United States Shipping Board to the Tebo Yacht Basin Company, Brooklyn, N. Y., at a price of $60,000. The Independence is the fourth vessel designated for electric drive.

Repairing Steamer, Brooklyn, N. Y.—The contract for repairing the Ocean Line steamer City of Columbus which struck on Lovellis Island recently, has been awarded to the Robins Dry Dock & Repair Company, which was the lowest bidder. The vessel was floated and received some temporary patches to her bottom plates at Fore River.

Pilot Boat, Baltimore, Md.—Bids were opened recently at the office of the Maryland Pilots' Association, foot of Broadway, for the construction of a pilot boat, 145 feet in length and 25 feet beam, to replace the Carmina at the Cape Henry Station. The proposed tender is to be of steel and is to be driven by triple expansion engines.

Machinery Installation Contract, San Francisco, Cal.—The Winton Engine Works and the Westinghouse Electric & Manufacturing Company have been awarded the contract for the machinery to be installed in the two new auto ferries to be built by the Golden Gate Ferry Company according to announcement made by R. Z. Dickie.

Tankers Building at San Pedro, Cal.—According to word received from O. B. Kebel, works manager of the Southwestern Shipbuilding Company, the company's yard is building two 12,000 tankers for the Union Oil Company. It is also announced that the company has secured contracts for three large tankers to be constructed for the Anglo-Saxon Petroleum Company, which will sail under the Dutch flag.

Overhaul Vessel, Baltimore, Md.—Extensive renovations are being made to the steamer Tred Avon of the Maryland, Delaware and Virginia Railroad Company's fleet. The vessel is to be used as an excursion boat this summer and will take the place of the Westmoreland. The vessel has a carrying capacity of about 600. Staterooms are to be torn from the boat in order to provide deck space.

Fuel Scows, Portland, Ore.—The Port Commission has awarded contracts for the construction of four fuel scows, two to be built by the St. Helens Shipbuilding Company, St. Helens, Ore., and two by the Portland Shipbuilding Company, Portland, Ore., for $12,000 each. The Portland Marine Ways & Boat Company was awarded a contract for building one donkey engine scow for $1,460.

Lightships Needed—Surveys made by the lighthouse service show that the wooden vessels owned by the Shipping Board are not suitable for its purpose and accordingly the next Congress will be asked to appropriate $4,000,000 to $5,000,000 for the construction of new lightships, of which approximately seventeen are needed. The $1,000,000 granted by the last Congress is sufficient only for the construction of three.

Steamer Repairs, Brooklyn, N. Y.—The contract for bottom repairs to the steamship Kaduna, of the Elder-Dempster Line of Liverpool, England, which recently went ashore, has been awarded at Halifax, N. S., to James Shewan & Son of Brooklyn. The award was made on competitive bidding of Canadian and New York yards, the Shewan Company bid involving about $150,000. The work will occupy approximately thirty days.

Vessels Building in Canada—Fifteen vessels, representing about 100,000 tons deadweight, are still to be delivered to the mercantile marine, according to statistics issued by the Department of Marine and Fisheries of Canada. Some of the Canadian yards, the report says, are also building vessels on foreign account. Complete Canadian returns for 1920 place the total gross tonnage built at 104,635 tons, representing 351 vessels of various classes.

Steamer Repairs, Shooters Island, N. Y.—A contract for miscellaneous repairs to the Shipping Board steamer Henry Steers has been awarded to the Standard Shipbuilding Corporation, Shooters Island, N. Y., on a bid of $2,400. Other bids included $2,405 by the Morgan Engineering Company; $2,531, by Ira L. Bushey & Son; $2,585, by Ramberg Dry Dock & Repair Company; the highest bid being $3,440 by the Neptune Marine & Boiler Works.

Painting Contract Pending, New York—Bids for the repainting of ten vessels of the New York City Fire Department are expected to be opened within the next month, according to official information obtainined by MARINE ENGINEERING. Nine fireboats and the motor patrol Velox, it was stated, are to be repainted and the work is expected to involve an outlay of approximately $10,000. No definite date for bid openings has yet been set.

Remodel Steamers, Baltimore, Md.—The Ericsson Line steamers Penn and Lord Baltimore, which have been tied up near St. George's for months, are to be remodeled and placed in operation on the route between Philadelphia and Baltimore, via the Chesapeake & Delaware Canal. It is said that the vessels will be cut down, remodeled and re-equipped before they are again placed in service. It is expected that an oil-burning system will be installed in the vessels.

Reconditioning Steamers—Contract for reconditioning the steamship George Washington was awarded to the Tietjen & Lang Dry Dock Company, Hoboken, N. J., on a bid of $838,000 and 110 running days. The Morse Dry Dock & Repair Company, Brooklyn, N. Y., was awarded the contract for reconditioning the America, on a bid of $572,330. Both vessels will be put in the service of the United States Mail Steamship Company when they are completed.

Shipping Board Contracts—Three contracts were recently awarded by the Shipping Board after competitive bidding, as follows: Steamer West Zeda to the Standard Shipbuilding Corporation, $12,845; steamer Western Sea to the New York Harbor Dry Dock Corporation, $4,077; and the West Wind to the Atlantic Basin, $1,352. The work of the West Zeda includes

the installation of Falk gears, repairs to the heating coil, changing coolers and oil pumps, reriveting parts of the hull and other minor work.

Three Bethlehem Yards Busy—Although announcing that the Harlan & Hollingsworth yard at Wilmington, Del., and the Moore marine shops at Elizabeth, N. J., will be shut down shortly as all orders are now being cleaned up, President E. G. Grace, of the Bethlehem Steel Corporation, is credited with the statement that the Company's shipyards at Fore River, Mass., Sparrows Point, Md., and the Union Plant at San Francisco, Cal., are operating at capacity with sufficient orders for the remainder of this year. While he predicted a "lean year" for 1921, he added there were signs of moderate improvement in the steel industry.

Steamers Wanted, Portland, Ore.—A general commission merchant in one of the British West Indies desires to purchase steamers, according to "Commerce," the weekly publication issued by the Portland Chamber of Commerce. One vessel is wanted with passenger and cargo accommodation space, of not more than 12 feet draft when loaded to carry 800 to 1,000 oxen; and one steamer, river boat, from 60 to 70 meters long to carry 200 to 250 oxen on deck, 7 with upper deck accommodations for sixty first class passengers, top from either shed deck, with captain and pilot accommodations, of 8 feet draft when loaded. Prices, full particulars and blue prints are requested. No reference offered. Refer to No. 34.591.

To Recondition Ferryboat, New York—Plans and specifications are in course of preparation for a general reconditioning of the hull and machinery of the steel hull ferryboat Ellis Island of the United States immigrant station, Ellis Island, New York harbor. The Ellis Island is a 160 foot steamer, and although no official figures were obtainable as to the extent of the appropriations by the Department of Labor for this work, it is understood that the specifications will call for virtually a complete renovation of the vessel inside and out. Bids will probably be opened at the office of Frederick A. Wallis, Commissioner of Immigration at Ellis Island, in about two weeks.

Repairing Schooners and Building New Craft, Seattle, Wash.—One of the most active plants on the waterfront is the marine ways of the Elliott Bay Marine Construction Company, C. O. Morrow, general manager, where many units of the local mosquito fleet are being overhauled and repaired for the coming fishing season. The Fanny Dutart, one of the largest schooners of the fleet, is being practically rebuilt, her house, decks and other items are being replaced. Several other vessels, including the Cherry, Elizabeth, and Imperial are also undergoing repairs at the plant. The construction of several small craft is also being undertaken.

Reconditioning Steamer, Hoboken, N. J.—The steamer Coppename, the third of a series of three vessels of the United Fruit Company fleet to undergo general reconditioning under contract with the W. & A. Fletcher Company, Hoboken, has arrived at the company's yards. In addition to dry docking for hull repairs the vessel is to have a new steel stern deck-house, additional cargo space, mast extensions, new rigging throughout, overhaul of all deck machinery, new bridge deck house, new dynamos and pumps, machinery and boiler overhauls. The entire ship will be rewired, new refrigeration coils throughout, and is to be scaled and painted inside and out. There will be complete new galleys and pantries, with various deck renewals. This contract involves close to half a million dollars and about seven weeks' time.

Ferryboats, New York—Plans and specifications will soon be under way for three 225-foot ferryboats for service to Staten Island, construction of which was assured by the recent decision of the Board of Estimate committee on financing budget to make a favorable report to the Board on Plant & Structures, Commissioner Grover A. Whalen's application for $1,560,000 in corporate stock with which to establish a new service to Stapleton. Bids for the construction of these boats will probably be advertised for in July, contract award to be made about August 1, with probable delivery of the boats next March. Tentative plans at present call for the synchronous type of motors, watertube boilers producing 250 pounds working pressure. Curtis turbines, superheaters, and boilers fitted for coal or oil consumption. Of the fund approved, $200,000 will be used for construction of slips and racks at Stapleton, plans for which are now under way.

Electric Equipment for Barges, Duluth, Minn.—The General Electric Company, Schenectady, N. Y., has contracted to supply electric auxiliary equipment for five Diesel-engine barges being built by the McDougall Duluth Shipbuilding Company, Duluth, Minn., for the Erie Canal Transportation Company of New York. The barges are 250 feet long, 36 feet beam and 10 feet draft, each being equipped with a 140-brake horsepower direct reversible Skandia Pacific Diesel engine. The displacement of these barges is 2,150 tons. The electric equipment will consist of three 10-kilowatt, 400 revolutions per minute generators, each driven by a 15-horsepower Diesel engine for auxiliary power and lighting on each barge. There will also be seven electric motors ranging from 10 to 1 horsepower, to be used on pumps, steering gear, etc. The barges will be very thoroughly equipped with electric auxiliaries, as they will have electric hydraulic steering gear, electric anchor windlasses and electric capstan.

SHIPYARDS AND DRYDOCKS

Boat Manufacturing Plant, Lynn, Mass.—The Shawmut Marine Company plans a number of buildings which will comprise a small boat manufacturing plant.

Drydock Equipment, Perth Amboy, N. J.—The Perth Amboy Dry Dock Company, foot of Broad Street, will install equipment at once at its new $10,000 drydock.

To Erect Shipyard, Alberta, Can.—The Albert & Arctic Transportation Company, Fort McMurray, has secured a site and will proceed with the erection of shipyards for the construction of vessels. W. J. West is manager.

Shipyard Leased, Tampa, Fla.—The Tampa Shipbuilding & Engineering Company has leased its yard to the Oscar Daniels Company, thus giving the Daniels Company extensive marine repair facilities.

Marine Railway, Etc., Miami, Fla.—It is reported that A. Pelsan will reconstruct the Pilkington Boat Yards. An additional basin will be dug, a marine railway built, and several hoists, etc., installed.

Repair Plant Sold, New York—The small dry dock and repair plant in New York harbor conducted by Wm. J. Gokey & Company, Inc., has been acquired by the Todd Shipyards Corporation.

Drydock Moorings, Portland, Ore.—The Port of Portland Commission has let a contract to Grant-Smith & Company, Seattle, Wash., for moorings for a new drydock, their bid being the lowest at $87,273.

Marine Repair Plant, Seattle, Wash.—David Rodgers who gained national prominence as a shipbuilder during the war has purchased the floating drydock and equipment of the old Seattle Dry Dock Company for a marine repair plant which is to be expanded.

Reorganizing Company, Channel Dyke, Tex.—The Seaboard Transportation & Shipping Company, which owns a yard at Channel Dyke, Pelican Spit, near Galveston, established in 1917, to build steel and wood vessels, is being reorganized and incorporated, and will soon announce its future plans.

Equipment, Etc., Harrisburg, Tex.—B. H. Elliott, Inc., which was recently incorporated to carry on marine repairs, will erect a 60 by 100 foot mill-construction machine shop for marine repairs, and will install 12 and 25 inch lathes, radial drills, planer and power hacksaw, etc.

Repair and Construction Yard, New Orleans—The Southern Yacht Club has started the organization of a co-operative boat repair and construction yard to be located on the grounds of the club at West End, to take care of the fleet of over 300 power boats which fly the S. Y. C. pennant.

Option on Shipyard Extended, Bristol, Pa.—The Government's option on the Merchant Shipbuilding Corporation's plant at Bristol has been indefinitely extended, pending a decision as to the course to be adopted by the Shipping Board. This option was to have expired recently. Under the agreement with the shipbuilding company, the board can purchase the land on which the plant is situated for $1,300,000. The company has an option to purchase the plant, which was built by the board at a cost of $15,000,000, or the board can remove its materials and equipment. A committee will be appointed by the Shipping Board and the shipbuilding corporation to work out a plan of settlement, it is said.

Yacht Repair Plant, Bridgeport, Conn.—Announcement is made of the formation of the McNab Boat Corporation, incorporated under the laws of the State with a common stock of $150,000. An option on the property of the Black Rock Yacht Club has been obtained, the intention being the establishment of an exclusive yacht repairing and outfitting station with winter storage quarters and club facilities. The new corporation has been formed by Alexander McNab of Bridgeport, inventor of marine appliances and president of the McNab Company. The work of altering the yacht club will commence in a few weeks and the plans call for the construction and installation of a railway drydock by the Crandall Engineering Company of Boston, which is expected to be in place inside of six months. The corporation will enter business as drydock owners, yacht builders and repairers, brokers, designers and consulting engineers. The drydock will be capable of hauling out vessels up to 300 tons and to a length of 125 feet. It is proposed to have the operation of this dock and other machinery effected by electric power.

PORT IMPROVEMENTS

Docks, Brunswick, Ga.—The city contemplates the construction of new docks. Address the Board of Trade.

Wharf, Miami, Fla.—The city contemplates the construction of wharf additions. Address the city engineer.

Dredging, Biloxi, Miss.—The Chamber of Commerce is interested in dredging the local channel.

Bulkhead, Etc., Eustis, Fla.—Bids were received until May 2, 1921, by P. Prioleau, city engineer, for the building of a bulkhead on the lake front.

Terminals, Charleston, S. C.—The city will issue $1,000,000 bonds for the development of the port and terminal facilities. Address Mayor Grace.

Wharf, Gulfport, Miss.—Contract has been let to W. W. Hammons to construct a wharf, at a cost of $12,680.53. H. D. Shaw is city engineer.

River Terminals, Memphis, Tenn.—City has voted bonds amounting to $500,000 for the extension of river terminals. W. B. Fowler is city engineer.

Pier, Gulfport, Fla.—Bonds amounting to $13,000 have been issued for public improvements including pier construction, yacht basin, lighting system, etc. S. J. Webb is town clerk.

Dredging, New York—The Department of Docks and Ferries, Pier A, North River, New York, will soon receive bids for dredging the main channels and building bulkheads in Jamaica Bay involving about $750,000.

Piers, New York—The Department of Docks, Pier A, North River, plans to build six piers along Jamaica Bay, New York, involving the expenditure of about $7,500,000, according to a recent report.

Docks, Dubuque, Iowa—The city plans to build steel and concrete docks, 200 to 300 feet long, involving the expenditure of about $100,000. S. Edwards, United States Engineer Office, is engineer.

Wharves, San Pedro, Cal.—Five new wharves in the inner harbor of San Pedro, Cal., have been recommended by the harbor engineers, and estimates of costs were ordered made by the Commissioner.

Wharf, Boston, Mass.—Messrs. Monks & Johnson, architects and engineers, will receive bids for building a wharf for the William Underwood Company in connection with their new canning factory to be erected.

Dredging Machinery, East Orange, N. J.—R. J. Rudd, 156 N. Grove Street, is reported to be in the market for equipment, including bucket operating derricks, electric hoists, cranes, clam shell buckets, etc.

Wharf, St. Rose, La.—The Petroleum Import & Export Company, a subsidiary of the Carson Petroleum Company, has let contract to N. G. Scott, Hennen Building, New Orleans, for the construction of a 500 by 30 foot wharf.

Docks, Miami, Fla.—Plans for trebling the capacity of the municipal docks and erect an additional 1,000-foot pier costing $400,000 are contemplated by the city. Address the city engineer.

Dredging, Grays Harbor, Wash.—Actual dredging work has been started at Cow Point, the scene of the most extensive operations on the port development programme, and it is expected will take the greater part of the year.

Rebuilding Pier, Galveston, Tex.—The Galveston Wharf Company has advertised for bids for rebuilding Pier 35, which was destroyed by fire last fall. The pier will be 800 feet long and 200 feet wide, and will be reconstructed in ninety days.

Harbor Improvements, Wilmington, Del.—Within the next few weeks $750,000 worth of harbor work is expected to be contracted for at Wilmington, Del., in addition to a considerable sum to be expended for the improvement of the Chesapeake and Delaware Canal.

Ferry Slips—New Hanover County Commissioners let a contract to the Diamond Steamboat & Wrecking Company to construct ferry-slip extensions on the east and west sides of the Cape Fear River. Plans were prepared by the War Department.

Approach and Pier, New York—H. H. Curran, president of the borough of Manhattan, let contract for building an approach and pier at the foot of Dyckman Street and North River, New York, to A. N. Spooner, Pier 11, North River; to cost $38,590.

Dredging, Newark, N. J.—The city has appropriated a sum of more than $1,000,000 for dredging a channel providing for a 30-foot depth at low water, and it is expected that a contract will be awarded for this work within the next two weeks.

Dock and Wharf, Marshfield, Ore.—Construction of the port dock and wharf was ordered by the port of Coos Bay commissioners, and announcement was made of the sale of the remaining portion of the $250,000 bond issue. Major T. F. McGinnis is engineer.

Wharves, Etc., Shiner, Tex.—It is reported that the Shiner Compress Company, of which V. J. Grunder is president, will soon erect wharves 120 feet by 500 feet, and sheds of mill construction, to be built under their own supervision. Two tubular boilers, each 72 inches by 18 feet, will also be installed.

Piers, New York City—According to announcement by Murray Hulbert, Commissioner of Docks, four 150-foot piers will be constructed in the North River beginning at a point near Thirty-sixth Street and extending to a point between 42d and 43d Streets, the piers to be separated by slips 332 feet in width. This will necessitate doing away with the several old piers now in place.

Ship Terminal, Trenton, N. J.—The State Board of Commerce and Navigation has approved the lease of 1,622 lineal feet of bulkheads along the Hudson River to the Luckenbach Terminal Company, of Bulls Ferry, N. J., at an annual rental of $87,500. A great ship terminal will be constructed on the property by this company, which operates steamers in all parts of the world.

Barge Terminal, New York, N. Y.—The State Engineer's office has begun the construction of the barge canal terminal at 137th Street on the Bronx side of the Harlem River. Actual construction of the terminal is the culmination of a plan submitted to the State Canal Board several years ago to improve the freight congestion at the various railroad terminals in the Bronx. The new terminal, which will cost $500,000, will be completed in about three months.

Terminals, Bulls Ferry, N. J.—The Luckenbach Terminals, Inc., organized by the Luckenbach Steamship Company, New York, for the construction of its proposed new freight terminal at Bulls Ferry, on the Hudson River near Edgewater, N. J., is reported to have preliminary plans under way for buildings which will include the installation of cranes, loading and unloading machinery, conveying equipment, etc. It is estimated that the terminal when completed will cost close to $10,000,000.

Piers, Philadelphia, Pa.—Director Sproule of the Department of Wharves, Docks and Ferries issued a license to the city for the construction of the two municipal piers which are to be known as the Girard piers, Nos. 1 and 2 North. The license provided for the building of bulkheads so that when the work is completed there will be a stretch of piers and bulkheads north from the Market Street ferries to pier 9. The cost of construction is about $2,500,000. The piers now occupying this site are being dismantled.

Appropriation for Harbor Improvements—The chief of army engineers has announced that the allotment of funds for Virginia river and harbor projects from the $15,000,000 lump sum appropriation bill passed by the last session of Congress is as follows: Norfolk harbor, $50,000; Rappahanock River, $10,000; Onancock River, $15,000; Pamunkey River, $3,000, which amounts are for maintenance only. There is a large unexpended balance of previous appropriations which is available to continue the improvement of Norfolk, Portsmouth and Newport News harbor and channel.

Harbor Facilities, Quebec, Can.—A sum of $250,000 will be spent this year in improving harbor facilities, and it is expected that a similar amount will be granted by the Dominion government each year until all the proposed improvements are completed, the cost of which is estimated at between $800,000 and $1,000,000. The most important work to be undertaken this year will be the erection of a huge fixed fender to replace the floating fenders at the embankment near Beauport Flats, thus enabling the largest Atlantic liner to dock without the least difficulty, and with a minimum loss of time.

Large Terminal, New Orleans, La.—The Carson Export & Import Company, a branch of the Carson Petroleum Company, has begun work on one of the largest terminals for handling petroleum products in the United States, on a large tract of land situated on the river about sixteen miles north of New Orleans. The wharfage contract has been let to Nat. G. Scott, of New Orleans, while the Lamson Company of Boston, Mass., will build the conveyors. Two warehouses, a pump house, boiler house, power house and shops will be erected. The William Garver Tank Corporation, Chicago, Ill., has the contract for twenty storage tanks. Contracts amounting to about $750,000 have been placed thus far.

Dredging Contracts Pending, New York—Sealed proposals will be received at the United States Engineer Office, Room 710, Army building, 39 Whitehall Street, New York, for dredging in Newtown Creek, New York. The total estimated quantity of material necessary to be removed within the specified limits to complete the work of excavating the channel to a depth of 20 feet at mean low water and ranging in width from 250 feet to 150 feet, is given as 200,000 cubic yards, and the amount available for payment of contractors' estimates is about $200,000. Bids will also be received at the same address until noon on May 12, 1921, for dredging in Gowanus Creek, New York harbor, New York, the total estimated quantity of material necessary to be removed being 123,000 cubic yards, scow measurement, and the amount available for the work is about $36,000.

GOVERNMENT WORK

Air Compressor, Bellevue, D. C.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install a reciprocating air compressor here.

Harbor Development, Great Lakes, Ill.—Specification 4358, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensive harbor improvements.

Elevated Steel Water Tank, Norfolk, Va.—Specification 4357, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build an elevated steel water tank.

Electric Traveling Platforms and Hoist, Lakehurst, N. J.—Specification 4356, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install electric traveling platforms and a hoist.

Water Tank, Chelsea, Mass.—Specification 4384, the Bureau of Yards and Docks, Navy Department, Washington, D. C., is receiving bids for the construction of a steel water tank tower and water mains.

TRADE PUBLICATIONS

Ellison Hardened Body Chuck.—A folder giving a complete description of Ellison hardened body drill chucks has been sent out by the E. Horton & Son Company, Windsor Locks, Conn.

The Labor Saver.—The April issue of the monthly publication of the Stephens-Adamson Mfg. Company, Aurora, Ill., contains articles on the uses of belt conveyors in handling such materials as coal, brick, ores and the like.

The Chart, the house organ of the Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal., will hereafter be issued as a monthly instead of bi-weekly publication. The magazine will appear enlarged in size and with colored covers, and will take a leading place in monthly publications of this type.

Forced Draught.—In Bulletin A-2 the James Howden & Company of America, Inc., Wellsville, New York, emphasizes the importance of the correct arrangement of forced draught systems and the necessity of care in the selection of equipment. General specifications for the complete Howden system are given.

The Cochrane Lines.—Open feed water heaters, metering heaters, independent meters, hot process water softeners, oil and steam separators, multi port drainers and other of the products of H. S. B. W. Cochrane Corporation, Philadelphia, are described and illustrated in a pamphlet sent out by this company. These devices are intended for the profitable utilization of exhaust steam and for heating softening and metering water.

Vertical Inclosed Self-Oiling Engines.—Engberg vertical self-oiling engines ranging in horsepower from 1 to 100 are completely described in catalogue No. 301 issued by Engberg's Electric & Mechanical Works, St. Joseph, Mich. These engines are especially adapted for auxiliary service and for operation in conjunction with automatic stokers, compressors, refrigerating machines, generating sets, and the like. Illustrations and detail drawings with specifications show the various applications of Engberg engines.

FOREIGN ACTIVITIES

To Improve Harbor, Pernambuco, S. A.—The Government of Brazil has provided an appropriation for harbor improvements at Pernambuco, according to recent reports.

Cranes, Cadiz, Spain—Tenders are expected to be invited for the provision of four electric 1-ton cranes and three 2-ton cranes for use on the new docks of the Alphonso XIII wharf, Cadiz, Spain.

New Shipbuilding Company, Amsterdam, Holland—It is reported that a new shipbuilding company, to be known as the Nierdelandische Dock A.-G., has been organized for the purpose of building and drydocking vessels, etc.

Italy.—The tonnage under construction in Italy amounts to 57 steel steamships of 413,727 tons deadweight, of which 24 are already being fitted out. This is the largest tonnage under construction in any European country except Great Britain.

Shipyard Merger, Liverpool, England.—The business and premises of the Mersey Engine Works Company, whose establishment is in Sefton Street, and who have hitherto done most of the ship repair work for Elder-Dempter & Company, will be taken over by Harland and Wolff. The employes will be re-engaged by the new management.

Clyde Output.—The tonnage launched on the Clyde during the month of February, consisted of 25 vessels of 82,500 tons gross, as against 7 vessels of 11,000 tons, in January, 1921, and 21 vessels of 49,000 tons, in February, 1914. For the first two months of this year the total output of tonnage on the Clyde is 32 vessels of 93,500 tons. The output for the first two months of the year 1920, was 25 vessels of about 72,600 tons.

Royal Mail Leases Quay.—The Royal Mail Steam Packet Company has signed a lease of the Stettin Quay, Hamburg, Germany, for the period of 21 years with the State authorities. The length of the quay will afford berthing accommodation for two transatlantic liners at the same time. The inauguration of the company's New York service by the "O" steamers will take place shortly and passengers sailing on the Ortova on April 30, will find that everything has been done to facilitate their embarkation.

Cunard Tonnage, England—A statement issued recently by the Cunard Line, which lost more than 50 percent of its pre-war tonnage through submarine warfare, shows that when the present building programme is completed, it will have with its associated lines 1,018,000 gross tons, or more than double its tonnage before the war. There are nineteen new vessels under way, six of which are for the Anchor service with an aggregate tonnage of 317,000. Among the new ones are the Cameronia, nearing completion, and her sister ships the Caledonia, California, Tuscania and Transylvania, all named for war-lost ships of the Anchor Line. The three largest ships of the line are the Aquitania, the Mauretania and the Berengaria, formerly the German liner Imperator and the third largest afloat.

NEW CORPORATIONS

The Inoko Dredging Company, Wilmington, Del., was incorporated with a capital of $170,000.

The Baltimore Derrick & Salvage Corporation, Baltimore, Md., has been incorporated with a capital of $300,000.

The Calumet Steamship Company, Wilmington, Del., has been incorporated with a capital of $200,000 to operate and navigate steamships.

The Grace Line, Inc., New York City, has been organized by A. G. Bates with a capital of $100,000 to do a navigation business.

The Hawk Steamship Line, New York, has recently been incorporated with a capital of $100,000 by M. Bab and others.

The Importers' Steamship Corporation, Dover, Del., has been incorporated, with a capital of $1,000,000, to own and operate boats.

The American Transatlantic Line, Inc., Dover, Del., has been incorporated, with a capital of $500,000, to own and operate boats.

The Port Jefferson Marine Railway Corporation, Port Jefferson, N. Y., has been incorporated with a capital of $60,000 by W. D. and M. C. Allen and G. M. Tooker.

The Falls Cities Ferry & Transportation Company, Jeffersonville, Ky., incorporated, with Froman M. Coots president, to operate line between Louisville and Jeffersonville.

Weeks Stevedoring Company, Inc., Manhattan, incorporated, with a capital of $100,000, to do a general stevedoring business. F. H. Weeks, 2550 Marion Avenue, incorporator.

The King Philip Steamship Company, Boston, Mass., has been incorporated with a capital of $300,000, with John J. Dixon, 729 Boylston Street, president and treasurer, William F. McDonnough and James F. Casey.

The Eastern Shore Marine Railway Company, St. Michaels, Md., has been incorporated with a capital of $100,000 by Harold A. Harrison, James F. and Walter C. Lowery, to carry on a dry docking business, etc.

The Mount Pleasant Boat Building Company, Columbia, S. C., has been incorporated, with a capital of $5,000, with Robert Magwood president-treasurer, and C. E. North, secretary-manager.

The Atlantic Boiler Cleaning Company, Newport News, Va., has been incorporated, with a capital of $50,000, to do ship repairs, etc. F. S. Deniston is president, and H. M. Deniston is secretary.

The New Orleans-Bluefields Fruit & Transportation Company, New Orleans, La., has been incorporated, with a capital of $2,000,000, and two steamships have been purchased. Ferdinand Katz, of New Orleans, is reported to be interested in this new company.

The Cowles Marine Salvage & Manufacturing Company, 532 South Green Street, Chicago, Ill., has been incorporated with a capital stock of $250,000 by John T. Cowles, M. E. Harwich and James D. Davidson, to manufacture machinery for raising and salvaging sunken vessels.

The Carle Shipbuilding & Repair Company, Rockaway Beach, L. I., N. Y., has been incorporated with a capital of $25,000 by W. J. Francis, R. F. Lenahan and C. H. Carle, Rockaway Beach, to operate a shipbuilding and marine repair plant.

The Townsend Repair Works, Richmond, S. I., New York, has been incorporated with a capital of $50,000 by R. and J. A. Townsend and C. J. Nygard, Richmond, to operate a marine repair and machine works. C. A. Clayton, 44 Court Street, Brooklyn, is a representative of the company.

Tidewater Transportation Company, Washington, D. C., has been incorporated, with a capital of $2,500,000 to operate lines from Washington to Southern Maryland, with Harry Allyn, general manager, 513 G Street, N. W. The new company contemplates lines to Salisbury and Elkton, Md., on Eastern Shore.

The Los Angeles Launch & Tugboat Company has been formed at San Pedro, Cal., with a capital of $200,000, according to Henry Levinson, general manager of the Peterson Launch & Tugboat Company, which is reported to have organized the new concern. The tug Hero has been purchased from Puget Sound interests for the new company.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Department, Washington, D. C.

President—Capt. A. J. Hepburn, U. S. N.
Secretary-Treasurer—Commander J. S. Evans, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.
Annual meeting and election, first Tuesday in October, other meetings at call of the President.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

29 West 39th Street, New York.

President—Rear Admiral W. L. Capps, C. C., U. S. N.
Secretary and Treasurer—Daniel H. Cox.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS

29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE

Naval Academy, Annapolis, Md.

President—Rear Admiral Bradley A. Fiske, U. S. N.
Secretary and Treasurer—Commander H. K. Hewitt, U. S. N.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS

National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN

President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 970 High St., Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; A. H. Haag, Narberth, Pa.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS

National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

ATLANTIC COAST SHIPBUILDERS' ASSOCIATION

1701 Walnut Street, Philadelphia, Pa.

Secretary—C. S. King.

AMERICAN STEAMSHIP OWNERS' ASSOCIATION

17 Battery Place, New York

Vice-President and General Manager—Winthrop L. Marvin.

AMERICAN STEAMSHIP OPERATORS' ASSOCIATION

17 Battery Place, New York

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA

Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS

5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED

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